



THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: DAVENNE et al.
Serial No.: 10/594,260
Filed: September 25, 2006
International Application No. PCT/GB05/01087
I.A. Filing Date: March 22, 2005
Docket No.: M04B101

Title: GEAR ASSEMBLY

Mail Stop Petitions
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

CERTIFICATE OF MAILING

I hereby certify that this correspondence and every writing referred to herein as being enclosed is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on October 26, 2007.
(Date)

Betty Lee
Printed name of person signing this certificate

Betty Lee
Signature of person mailing

Sir:

PETITION FOR FILING UNDER 37 C.F.R. § 1.47(a)

The applicant(s) hereby respectfully petition(s) the Commissioner of Patents and Trademarks to accept the filing of the above-identified application by other than all of the joint inventors in accordance with the provisions of 37 C.F.R. § 1.47(a).

Attached hereto is: (a) a declaration of joint inventor(s) John Cambridge Smith on his (or her) own behalf and on behalf of the omitted inventor(s); and (b) a statement of facts in support of filing on behalf of the omitted inventor(s).

The name, address and citizenship of the joint inventor who refuses to execute the application or cannot be reached is as follows:

Full name: Tristan Richard Ghislain Davenne

Citizenship: United Kingdom

Residence address: 15 CHAPEL ROAD
EPPING
ESSEX
CM16 5DS

Country of residence: United Kingdom

The Commissioner is hereby authorized to charge to Deposit Account No. 50-4244, the \$200.00 fee required under 37 CFR 1.17(g).

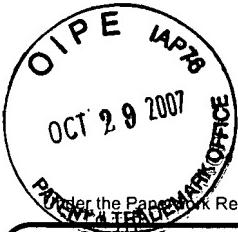
The Commissioner is requested to grant any necessary extension of time and is authorized to charge any additional fee, if required, to our Deposit Account No. 50-4244. This request is submitted **in triplicate**.

Respectfully submitted,

Date: 10/26/07
Edwards Vacuum, Inc.
Legal Services-Intellectual Property
55 Madison Avenue, Suite 400
Morristown, NJ 07960


Mary K. Nicholes
Mary K. Nicholes
Reg. No. 56,238
Patent Agent for Applicant(s)
(973) 285-3309

Customer No. 71134



PTO/SB/17p (10-07)

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**PETITION FEE
Under 37 CFR 1.17(f), (g) & (h)
TRANSMITTAL**
(Fees are subject to annual revision)

Send completed form to: Commissioner for Patents
P.O. Box 1450, Alexandria, VA 22313-1450

Application Number	10/594,260
Filing Date	September 25, 2006
First Named Inventor	DAVENNE et al.
Art Unit	
Examiner Name	
Attorney Docket Number	M04B101

Enclosed is a petition filed under 37 CFR § 1.47 that requires a processing fee (37 CFR 1.17(f), (g), or (h)). Payment of \$ 200.00 is enclosed.

This form should be included with the above-mentioned petition and faxed or mailed to the Office using the appropriate Mail Stop (e.g., Mail Stop Petition), if applicable. For transmittal of processing fees under 37 CFR 1.17(i), see form PTO/SB/17i.

Payment of Fees (small entity amounts are NOT available for the petition fees)

- The Commissioner is hereby authorized to charge the following fees to Deposit Account No. 50-4244:
 petition fee under 37 CFR 1.17(f), (g) or (h) any deficiency of fees and credit of any overpayments
 Enclose a duplicative copy of this form for fee processing.
- Check in the amount of \$ _____ is enclosed.
- Payment by credit card (Form PTO-2038 or equivalent enclosed). Do not provide credit card information on this form.

Petition Fees under 37 CFR 1.17(f): Fee \$400 Fee Code 1462

For petitions filed under:

- § 1.36(a) - for revocation of a power of attorney by fewer than all applicants
- § 1.53(e) - to accord a filing date.
- § 1.57(a) - to accord a filing date.
- § 1.182 - for decision on a question not specifically provided for.
- § 1.183 - to suspend the rules.
- § 1.378(e) - for reconsideration of decision on petition refusing to accept delayed payment of maintenance fee in an expired patent.
- § 1.741(b) - to accord a filing date to an application under § 1.740 for extension of a patent term.

Petition Fees under 37 CFR 1.17(g): Fee \$200 Fee Code 1463

For petitions filed under:

- § 1.12 - for access to an assignment record.
- § 1.14 - for access to an application.
- § 1.47 - for filing by other than all the inventors or a person not the inventor.
- § 1.59 - for expungement of information.
- § 1.103(a) - to suspend action in an application.
- § 1.136(b) - for review of a request for extension of time when the provisions of section 1.136(a) are not available.
- § 1.295 - for review of refusal to publish a statutory invention registration.
- § 1.296 - to withdraw a request for publication of a statutory invention registration filed on or after the date the notice of intent to publish issued.
- § 1.377 - for review of decision refusing to accept and record payment of a maintenance fee filed prior to expiration of a patent.
- § 1.550(c) - for patent owner requests for extension of time in *ex parte* reexamination proceedings.
- § 1.956 - for patent owner requests for extension of time in *inter partes* reexamination proceedings.
- § 5.12 - for expedited handling of a foreign filing license.
- § 5.15 - for changing the scope of a license.
- § 5.25 - for retroactive license.

Petition Fees under 37 CFR 1.17(h): Fee \$130 Fee Code 1464

For petitions filed under:

- § 1.19(g) - to request documents in a form other than that provided in this part.
- § 1.84 - for accepting color drawings or photographs.
- § 1.91 - for entry of a model or exhibit.
- § 1.102(d) - to make an application special.
- § 1.138(c) - to expressly abandon an application to avoid publication.
- § 1.313 - to withdraw an application from issue.
- § 1.314 - to defer issuance of a patent.


Signature

Mary K. Nicholes

Typed or printed name

10/26/07
Date

56,238

Registration No., if applicable

This collection of information is required by 37 CFR 1.17. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 5 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

OCT 29 2007

Applicant(s): Davenne et al.

Appln. No.: PCT/GB2005/001087

I.A. Filing Date: March 22, 2005

Title: GEAR ASSEMBLY

Attorney Docket: M04B101

National Stage Appln No. 10/594,260

Priority Date: March 26, 2004

Commissioner for Patents

P.O. Box 1450

Alexandria, VA 22313-1450

CERTIFICATE OF MAILING

I hereby certify that this correspondence and every writing referred to herein as being enclosed is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on October 26, 2007.
(Date)

Betty Lee

Printed name of person signing this certificate

Betty Lee

Signature of person mailing

STATEMENT OF FACTS IN SUPPORT OF FILING**ON BEHALF OF NONSIGNING INVENTOR (37 C.F.R. § 1.47)**

This statement is made as to the facts that are relied upon to establish the diligent effort made to secure the execution of the declaration by the nonsigning inventor for the above-identified patent application. This statement is being made by the available person having first-hand knowledge of the facts recited herein.

Last Known Address of the Nonsigning Inventor

Tristan Richard Ghislain Davenne

Full Name of Nonsigning Inventor

15 Chapel Road, Epping, Essex, CM16 5DS, United Kingdom

Last Known Address of Nonsigning Inventor

Details of Efforts to Reach Nonsigning Inventor

On August 30, 2007, I sent Mr. Tristan Richard Ghislain Davenne the attached letter dated August 28, 2007 which was sent to him by courier (i.e. DHL No. 7407809743) together with a copy of patent application serial number 10/594,260, filed September 25, 2006, entitled Gear Assembly. Also enclosed with the letter were an inventor's Declaration form, an Assignment form, and a Power of Attorney form for his review and execution. A copy of the August 28, 2007 letter, patent application, and forms as sent to Mr. Davenne are attached. I sent the letter to Mr. Davenne's last known address at the time. Thereafter I learned that Mr. Davenne had moved as shown in the attached tracking history for DHL No. 7407809743, the entry entitled "9/3/2007 10:18 am."

On September 25, 2007, I obtained from my assistant, Ms. Betty Lee, a more recent address for Mr. Davenne provided by Ms. Julia Tribe, the Intellectual Property Formalities Administrator of Edwards, Ltd. (formerly the The BOC Group, plc and The Linde Group and parent of Edwards Vacuum, Inc.) in the United Kingdom. A copy of the September 25, 2007 email is attached.

On October 9, 2007, I sent Mr. Davenne the attached letter dated October 9, 2007 which was sent to him by courier (i.e. DHL No. 7407809953) together with a copy of patent application serial number 10/594,260, filed September 25, 2006, entitled Gear Assembly. Also enclosed with the letter were an inventor's Declaration form, an Assignment form, and a Power of Attorney form for his review and execution. A copy of the October 9, 2007 letter, patent application, and forms as sent to Mr. Davenne are attached. I sent the letter to Mr. Davenne's last known address at the time. Thereafter I learned that Mr. Davenne signed for the package and that the shipment was delivered as shown in the attached tracking history for DHL No. 7407809953, the entries entitled "Signed for by" and "10/11/2007 10:46 am."

On October 22, 2007, I sent Mr. Davenne the attached follow-up letter dated October 22, 2007 which was sent to him by courier (i.e. DHL No. 7407809032). The letter requested Mr.

Davenne to contact me as soon as possible. Thereafter I learned that Mr. Davenne signed for the package and that the shipment was delivered as shown in the attached tracking history for DHL No. 7407809032, the entries entitled "Signed for by" and "10/24/2007 11:12 am." Mr. Davenne has neither sent executed application papers nor contacted me.

In addition to my above-mentioned efforts to contact Mr. Davenne and obtain execution of the formal documents, and upon information and belief, my former colleagues in the United Kingdom previously attempted to contact Mr. Davenne and obtain execution of the documents. Attached are three letters dated November 8, 2006, November 22, 2006 and December 20, 2006 addressed to Mr. Davenne and from Ms. Cathy Kelly, Intellectual Property Formalities Administrator of BOC Edwards (now Edwards, Ltd. and formerly The BOC Group, plc and The Linde Group). Notably, Mr. Davenne left BOC Edwards in November 2006. Also attached is a May 11, 2007 email from Ms. Tribe to Ms. Lee explaining that inventor John Smith signed the documents and that the documents were given to Mr. Davenne for his execution, "but he refused to sign them and left them on his desk upon departure."

Details of Refusal of Nonsigning Inventor to Sign Application Papers

Despite the above-mentioned attempts by myself and my colleagues to contact Mr. Davenne, he has still not executed the application papers. Accordingly, in view of the above-mentioned facts, Mr. Davenne has refused to join in the application.

Mary K. Nicholes

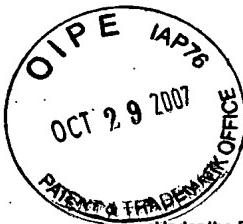
Name of Person making Statement

Mary K. Nicholes

Signature of Person making Statement

10/26/07

Date



**POWER OF ATTORNEY
and
CORRESPONDENCE ADDRESS
INDICATION FORM**

Application Number	10/594,260
Filing Date	September 25, 2006
First Named Inventor	DAVENNE et al.
Title	GEAR ASSEMBLY
Art Unit	
Examiner Name	
Attorney Docket Number	M04B101

I hereby revoke all previous powers of attorney given in the above-identified application.

I hereby appoint:

Practitioners associated with the Customer Number:

020411

OR

Practitioner(s) named below:

Name	Registration Number

as my/our attorney(s) or agent(s) to prosecute the application identified above, and to transact all business in the United States Patent and Trademark Office connected therewith.

Please recognize or change the correspondence address for the above-identified application to:

The address associated with the above-mentioned Customer Number:

OR

The address associated with Customer Number:

020411

OR

Firm or Individual Name

Address

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State

Zip

Country

Telephone

Email

I am the:

Applicant/Inventor.

Assignee of record of the entire interest. See 37 CFR 3.71.
Statement under 37 CFR 3.73(b) is enclosed. (Form PTO/SB/96)

SIGNATURE of Applicant or Assignee of Record

Signature		Date	11/12/2006
Name	JOHN CAMBRIDGE SMITH	Telephone	
Title and Company			

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below*.

*Total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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LEGAL SERVICES - INTELLECTUAL PROPERTY

55 Madison Avenue
Morristown, NJ 07960
USA

Tel: +1 973 285 3309
In USA: +1 800 848 9800
Fax: +1 973 285 3320

Mr. Tristan Richard Ghislain Davenne
5 Adelaide Square
Shoreham-by-Sea
West Sussex
BN43 6LN
United Kingdom

August 28, 2007

RE: U.S. Patent Application No. 10/594,260
Filing Date: September 25, 2006
Title: GEAR ASSEMBLY
Docket No. M04B101

Dear Mr. Davenne:

Enclosed please find a copy of the above-referenced patent application for the invention of which you are a co-inventor. Also enclosed for your execution is (a) an inventor's Declaration to be signed (and dated) by you in blue ink; (b) an Assignment which you should sign on the same date that you sign (and date) the Declaration; and (c) a Power of Attorney and Correspondence Address Indication Form which you should also please sign and date.

Please review the application carefully and make sure that you agree with its contents prior to executing the Declaration.

If there are no changes to be made, please read the Declaration carefully, paying particular attention to the fact that, by signing the Declaration, you acknowledge the following:

- a) To the best of your knowledge, you are the first and true inventor of the subject matter of the patent application.
- b) You owe the highest duty of candor and good faith in your dealings with the Patent and Trademark Office, and in discharge of this duty, you must disclose to the Patent and Trademark Office any information of which you are aware that is "material to examination of this application" as defined in the attached 37 CFR § 1.56. Such information is material when, at least in part, there is a substantial likelihood that a patent examiner would consider it important in deciding whether the subject matter of the present application is patentable.

After these steps have been taken, please sign (and date) the Declaration.

The Assignment should be signed by you and witnessed at the same time that you sign and date the Declaration.

The Power of Attorney and Correspondence Address Indication Form should be signed and dated by you.

Please return the application copy with the signed Declaration, signed Assignment and signed Power of Attorney. The extra copy of the application is for your records.

I look forward to receiving these papers as soon as possible, but by no later than September 14, 2007.

On behalf of BOC Edwards, Inc., thank you once for your submittal of the above-referenced invention record on which the patent application is based. If you have any concerns or questions, please do not hesitate to contact me.

Best Regards,



Kristi Nicholes | Patent Agent | Edwards

Tel: 1 973 285 3309 | Mobile: 1 862 812 4944 | kristi.nicholes@edwardsvacuum.com

55 Madison Avenue, Morristown, NJ 07960, USA | www.edwardsvacuum.com
BOC Edwards Inc.

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Shipper's Account Number

Contact Name

Betty Lee

Shipper's Reference (up to 35 characters)

M04B101

Company Name

BOC EDWARDS, INC

Address

STE 400

55 MADISON AVE

MORRISTOWN, NJ

Phone, Fax, or E-mail (required)

023607337

Post/ZIP Code (required)

973-285-3314

3 To (Receiver)

Company Name

BOC Edwards, Inc.

Contact Person

Betty Lee

Delivery Address DHL Cannot Deliver to a PO Box

55 Madison Avenue, Suite 400

Morristown, New Jersey

Phone, Fax, or E-mail (required)

07960

Post/ZIP Code (required)

973-285-3314

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**DECLARATION FOR UTILITY OR
DESIGN
PATENT APPLICATION**
(37 CFR 1.63)

Declaration Submitted With Initial Filing

OR

Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)

Attorney Docket Number	M04B101
First Named Inventor	DAVENNE et al.
COMPLETE IF KNOWN	
Application Number	10/594,260
Filing Date	September 25, 2006
Art Unit	
Examiner Name	

I hereby declare that:

Each inventor's residence, mailing address, and citizenship are as stated below next to their name.

I believe the inventor(s) named below to be the original and first inventor(s) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

GEAR ASSEMBLY

(Title of the Invention)

the specification of which

is attached hereto

OR

was filed on (MM/DD/YYYY) 03/22/2005 as United States Application Number or PCT International

Application Number PCT/GB2005/001087 and was amended on (MM/DD/YYYY) (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or (f), or 365(b) of any foreign application(s) for patent, inventor's or plant breeder's rights certificate(s), or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent, inventor's or plant breeder's rights certificate(s), or any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached? YES	Certified Copy Attached? NO
0406887.0	GB	03/26/2004	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>

Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

[Page 1 of 2]

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 21 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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DECLARATION — Utility or Design Patent Application

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Country

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

NAME OF SOLE OR FIRST INVENTOR:	<input type="checkbox"/> A petition has been filed for this unsigned inventor
--	---

Given Name (first and middle [if any])	Family Name or Surname
--	------------------------

TRISTAN RICHARD GHISLAIN	DAVENNE
--------------------------	---------

Inventor's Signature	Date
----------------------	------

Residence: City Shoreham-By-Sea, West Sussex	State	Country UNITED KINGDOM	Citizenship UNITED KINGDOM
---	-------	---------------------------	-------------------------------

Mailing Address 5 ADELAIDE SQUARE

City Shoreham-By-Sea, West Sussex	State	Zip BN43 6LN	Country UNITED KINGDOM
--------------------------------------	-------	-----------------	---------------------------

<input checked="" type="checkbox"/> Additional inventors or a legal representative are being named on the <u>one</u> supplemental sheet(s) PTO/SB/02A or 02LR attached hereto.
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DECLARATION		ADDITIONAL INVENTOR(S) Supplemental Sheet	
Page 1 of 1			
Name of Additional Joint Inventor, if any:		<input type="checkbox"/> A petition has been filed for this unsigned inventor	
Given Name (first and middle (if any))		Family Name or Surname	
JOHN CAMBRIDGE		SMITH	
Inventor's Signature		Date	
STEYNING, WEST SUSSEX Residence: City	State	UNITED KINGDOM Country	UNITED KINGDOM Citizenship
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Name of Additional Joint Inventor, if any:		<input type="checkbox"/> A petition has been filed for this unsigned inventor	
Given Name (first and middle (if any))		Family Name or Surname	
Inventor's Signature		Date	
Residence: City	State	Country	Citizenship
Mailing Address			
City	State	Zip	Country
Name of Additional Joint Inventor, if any:		<input type="checkbox"/> A petition has been filed for this unsigned inventor	
Given Name (first and middle (if any))		Family Name or Surname	
Inventor's Signature		Date	
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This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 21 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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§ 1.56 DUTY TO DISCLOSE INFORMATION MATERIAL TO PATENTABILITY. (Added 3/16/92)

(a) A patent by its very nature is affected with a public interest. The public interest is best served, and the most effective patent examination occurs when, at the time an application is being examined, the Office is aware of and evaluates the teachings of all information material to patentability. Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability as defined in this section. The duty to disclose information exists with respect to each pending claim until the claim is cancelled or withdrawn from consideration, or the application becomes abandoned. Information material to the patentability of a claim that is cancelled or withdrawn from consideration need not be submitted if the information is not material to the patentability of any claim remaining under consideration in the application. There is no duty to submit information which is not material to the patentability of any existing claim. The duty to disclose all information known to be material to patentability is deemed to be satisfied if all information known to be material to patentability of any claim issued in a patent was cited by the Office or submitted to the Office in the manner prescribed by §§ 1.97(b)-(d) and 1.98. However, no patent will be granted on an application in connection with which fraud on the Office was practiced or attempted or the duty of disclosure was violated through bad faith or intentional misconduct. The Office encourages applicants to carefully examine: (Added 3/16/92)

- (1) prior art cited in search reports of a foreign patent office in a counterpart application. (Added 3/16/92)
- (2) the closest information over which individuals associated with the filing or prosecution of a patent application believe any pending claim patentability defines, to make sure that any material information contained therein is disclosed to the Office. (Added 3/16/92)

(b) Under this section, information is material to patentability when it is not cumulative to information already of record or being made of record in the application, and (Added 3/16/92)

- (1) It establishes, by itself or in combination with other information, a prima facie case of unpatentability of a claim; or (Added 3/16/92)
 - (2) It refutes, or is inconsistent with, a position the applicant takes in: (Added 3/16/92)
 - (i) Opposing an argument of unpatentability relied on by the Office, or (Added 3/16/92)
 - (ii) Asserting an argument of patentability. (Added 3/16/92)
- (2) A prima facie case of unpatentability is established when the information compels a conclusion that a claim is unpatentable under the preponderance of evidence, burden-of-proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any consideration is given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability. (Added 3/16/92)
- (c) Individuals associated with the filing or prosecution of a patent application within the meaning of this section are: (Added 3/16/92)
 - (1) Each inventor named in the application: (Added 3/16/92)
 - (2) Each attorney or agent who prepares or prosecutes the application; and (Added 3/16/92)
 - (3) Every other person who is substantively involved in the preparation or prosecution of the application and who is associated with the inventor, with the assignee or with anyone to whom there is an obligation to assign the application. (Added 3/16/92)
- (d) Individuals other than the attorney, agent or inventor may comply with this section by disclosing information to the attorney, agent, or inventor. (Added 3/16/92)
- (e) In any continuation-in-part application, the duty under this section includes the duty to disclose to the Office all information known to the person to be material to patentability, as defined in Paragraph (b) of this section, which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application. (Added 11/7/00).

International Application No.
PCT/GB2005/001087

National Stage
Preliminary Amendment

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: DAVENNE et al. Attorney Docket No.: M04B101
International Application No.: PCT/GB2005/001087 Group Art Unit:
International Application Filing Date: March 22, 2005
National Application Filed: Concurrently Herewith
Title: GEAR ASSEMBLY

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

PRELIMINARY AMENDMENT

37 C.F.R. § 1.115

Dear Sir:

Prior to examining the above-identified application, please amend the above-identified application as follows:

Amendments to the Specification begin on page 2.

Amendments to the Claims begin on page 6.

Amendments to the Drawings begin on page 9.

Remarks begin on page 10.

IN THE SPECIFICATION

Please amend page 1 by inserting the following heading between the title of the invention and the first paragraph:

"FIELD OF THE INVENTION"

Please amend page 1 by inserting the following heading between the first and second paragraphs:

"BACKGROUND OF THE INVENTION"

Please amend page 2 by inserting the following heading on line 8:

"SUMMARY OF THE INVENTION"

Please amend page 4 by inserting the following heading on line 14:

"BRIEF DESCRIPTION OF THE DRAWINGS"

Please amend page 4 by inserting the following heading on line 25:

"DETAILED DESCRIPTION OF THE INVENTION"

Please amend page 7 by inserting the following language between the "CLAIMS" heading and claim 1:

"I/We claim:"

Please amend pages 2-4 by deleting the following text beginning on page 2 line 20 and ending on page 4 line 2 as follows:

~~"In the preferred embodiment, the resilient coupling is located within a drive mechanism for transferring torque between the members. For example, one member may comprise one or more recesses each for receiving a detent of the other member for transferring torque between the members, the resilient coupling being located between opposing surfaces of the or each recess and detent.~~

~~The means for inhibiting torsional vibrations and noise thus preferably comprises at least one resilient member located between opposing surfaces of the~~

members. In the preferred embodiment, a plurality of resilient members are each located between respective opposing surfaces of the members.

The resilient members may be conveniently provided by a number of springs, for example, metal torsional springs or translational springs including flat, disc and coil springs acting along a tangential line within the radius of the member. Alternatively, repelling magnets could be used with the resulting stiffness being proportional to the magnetic flux. Finally in some applications use of viscoelastic materials may be appropriate.

Providing means such as a spring between the hub member and the annular member can allow the torsional stiffness of the gear to be controlled. By providing a spring between the members the inertia that is accelerated and decelerated due to eccentricity is reduced. As the gear is accelerated, the spring is designed to compress so that the shaft can remain at a constant speed. This isolation of the shaft from eccentricity induced gear acceleration reduces the oscillations in drive torque and will increase the eccentricity at which the gears will leave mesh.

In the event of an external torque other than that resulting from gear eccentricity causes the gears to leave mesh, the spring will act to absorb the impact that occurs as the gears come back into mesh and thus act to bring the assembly back to the linear, in mesh, operating region. In support of this argument, non-linear analysis of tooth-to-tooth slapping has shown that the gears can only leave mesh if the overall torsional stiffness is above a certain level. In other words, low torsional stiffness rotating machinery ('weak shafts') would always remain in mesh.

This aspect of the invention extends to a vacuum pump comprising at least two shafts connected together by a gear assembly as aforementioned. For example, a high speed Roots blower vacuum pump includes Roots profile rotors rotating in a pumping chamber with a 1:1 gear ratio. Torsional vibrations between the gears can be a problem when operating at maximum speed and ultimate pressure (the best vacuum achievable by the pump). The noise generated has been shown to depend on gear eccentricity, and is present with the available manufacturing gear wheel tolerances. An experimental prototype gear according to the invention fitted to the driven shaft has been shown to eliminate gear tooth-to-tooth slapping with gear eccentricities that normally result in a pump prone to this noise problem."

Please amend page 4 beginning on line 30 as follows:

"...teeth 16. There is a resilient coupling located between the hub member 12 and the annular member 14. In the preferred embodiment, the resilient coupling is located within a drive mechanism for transferring torque between the members. For example, one member may comprise one or more recesses each for receiving a detent of the other member for transferring torque between the members, the resilient coupling being located between opposing surfaces of the or each recess and detent. The means for inhibiting torsional vibrations and noise thus preferably comprises at least one resilient member located between opposing surfaces of the members. In the preferred embodiment, a plurality of resilient members are each located between respective opposing surfaces of the members. The shaft received by the hub member 12 may be either a drive shaft or a driven shaft of the pump. A bearing assembly 18 is carried by the bore of the annular member 14 and the shaft."

Please amend page 5 beginning on line 14 by inserting the following text:

"The resilient members may be conveniently provided by a number of springs, for example, metal torsional springs or translational springs including flat, disc and coil springs acting along a tangential line within the radius of the member. Alternatively, repelling magnets could be used with the resulting stiffness being proportional to the magnetic flux.

Providing means such as a spring between the hub member and the annular member can allow the torsional stiffness of the gear to be controlled. By providing a spring between the members the inertia that is accelerated and decelerated due to eccentricity is reduced. As the gear is accelerated, the spring is designed to compress so that the shaft can remain at a constant speed. This isolation of the shaft from eccentricity-induced gear acceleration reduces the oscillations in drive torque and will increase the eccentricity at which the gears will leave mesh.

As shown in Figure 3, flat springs 24a, 24b are located within each recess 22 between the facing radial surfaces 26, 28 of the detent 20 and recess 22. The springs 24a, 24b have a stiffness chosen to substantially..."

Please amend page 6 beginning on line 9 as follows:

"In the event of an external torque other than that resulting from gear eccentricity causes the gears to leave mesh, the spring will act to absorb the impact that occurs as the gears come back into mesh and thus act to bring the assembly back to the linear, in-mesh, operating region. In support of this argument, non-linear analysis of tooth-to-tooth slapping has shown that the gears can only leave mesh if the overall torsional stiffness is above a certain level. In other words, low torsional stiffness rotating machinery ('weak shafts') would always remain in mesh.

This aspect of the invention extends to a vacuum pump comprising at least two shafts connected together by a gear assembly as aforementioned. For example, a high-speed Roots blower vacuum pump includes Roots profile rotors rotating in a pumping chamber with a 1 :1 gear ratio. Torsional vibrations between the gears can be a problem when operating at maximum speed and ultimate pressure (the best vacuum achievable by the pump). The noise generated has been shown to depend on gear eccentricity, and is present with the available manufacturing gear wheel tolerances. An experimental prototype gear according to the invention fitted to the driven shaft has been shown to eliminate gear tooth-to-tooth slapping with gear eccentricities that normally result in a pump prone to this noise problem.

While the foregoing description and drawings represent the preferred embodiments of the present invention, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the true spirit and scope of the present invention."

IN THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in the application.

LISTING OF CLAIMS

1. (currently amended) A gear assembly for transmitting torque from one shaft to another, ~~the gear assembly comprising:~~ two intermeshing gears mounted on respective shafts, one of the gears comprising a hub member for receiving one of the shafts; a toothed annular member mounted for rotation with the hub member; and means for reducing torsional vibrations and noise provided between the hub member and the annular member and having a stiffness capable of reducing torsional vibrations and noise induced during rotation of the gears by the eccentricity of at least one of the gears.
2. (currently amended) ~~A~~The gear assembly according to ~~Claim~~ 1, wherein the means for reducing torsional vibrations and noise comprises means for increasing the critical eccentricity of the gear.
3. (currently amended) ~~A~~The gear assembly according to ~~any preceding claim 1,~~ wherein the means for reducing torsional vibrations and noise comprises a resilient coupling between the hub member and the annular member.
4. (currently amended) ~~A~~The gear assembly according to ~~any preceding claim 1,~~ wherein the means for reducing torsional vibrations and noise is located between a radial surface of the hub member and an opposing radial surface of the annular member.
5. (currently amended) ~~A~~The gear assembly according to ~~any preceding claim 1,~~ wherein the means for reducing torsional vibrations and noise is located

within a drive mechanism for transferring torque between the hub member and the annular member.

6. (currently amended) A-The gear assembly according to Cclaim 5, wherein one of the hub member and the annular member comprises a recess for receiving a detent of the other of the hub member and the annular member for transferring torque between the hub member and the annular member, the means for reducing torsional vibrations and noise being located between opposing surfaces of the recess and the detent.
7. (currently amended) A-The gear assembly according to Cclaim 6, wherein said one of the hub member and the annular member comprises a plurality of said recesses each for receiving a respective detent of the other of the hub member and the annular member, the means for reducing torsional vibrations and noise being located between opposing surfaces of each recess and detent.
8. (currently amended) A-The gear assembly according to any preceding claim 1, wherein the means for inhibiting torsional vibrations and noise comprises at least one resilient member located between opposing surfaces of the hub member and the annular member.
9. (currently amended) A-The gear assembly according to Cclaim 8, wherein the means for inhibiting torsional vibrations and noise comprises a plurality of resilient members each located between respective opposing surfaces of the hub member and the annular member.
10. (currently amended) A-The gear assembly according to Cclaim 9, wherein each resilient member comprises a spring for providing torsional resistance.
11. (currently amended) A-The gear assembly according to Cclaim 9, wherein each resilient member comprises a plurality of springs for providing torsional resistance.

12. (currently amended) A The gear assembly according to Claim 9, wherein each resilient member comprises a viscoelastic member.
13. (currently amended) A The gear assembly according to any of Claims 1 to 7, wherein the means for reducing torsional vibrations and noise comprises mutually repelling magnets provided on opposing surfaces of the hub member and the annular member.
14. (currently amended) A The gear assembly according to any preceding claim 1, wherein the means for reducing torsional vibrations and noise is arranged to maintain the phase relationship between the shafts.
15. (currently amended) A The gear assembly according to Claim 14, wherein the means for reducing torsional vibrations and noise is arranged to permit a solid drive to be established between the hub member and the annular member above a predetermined drive torque.
16. (currently amended) A vacuum pump comprising at least two shafts connected together by a gear assembly comprising two intermeshing gears mounted on respective shafts, one of the gears comprising a hub member for receiving one of the shafts;
a toothed annular member mounted for rotation with the hub member; and
means for reducing torsional vibrations and noise provided between the hub member and the annular member and having a stiffness capable of reducing torsional vibrations and noise induced during rotation of the gears by the eccentricity of at least one of the gears. according to any preceding claim.
17. (currently amended) A gear for transmitting torque from one shaft to another, the gear comprising:
a hub member for receiving one of the shafts;
a toothed annular member mounted for rotation with the hub member; and

means provided between the hub member and the annular member having a stiffness capable of reducing torsional vibrations and noise induced during use by eccentricity of the annular member.

18. Cancelled

IN THE DRAWINGS

Fig. 1 has been amended to include a "Prior Art" legend.

Fig. 3 has been amended to included identifier "28".

REMARKS

This application is being filed concurrently with entry into the National Stage (Chapter 1) of International Application No. PCT/GB2005/001087 which claims the priority of Great Britain Patent Application No. 0406887.0.

This Preliminary Amendment was considered when calculating the filing fee. Accordingly, the total number of claims specified on the Transmittal Letter is 17 and the number of independent claims is 3.

The Specification has been amended to place the application in proper U.S. format. Headings have been added to each section. In addition, the text deleted from page 2 lines 20-30 has been inserted on page 4 line 30. The text deleted from page 3 lines 1-15 has been inserted on page 5 line 14. Finally, the text deleted from page 3 lines 17-32 and page 4 lines 1-2 has been inserted on page 6 line 10. No new matter has been introduced.

Claims 1-17 remain in the application and claim 18 has been cancelled. Claims 1-17 have been amended to eliminate multiple dependencies in these claims and to place the claims in proper U.S. format. Figures 1 and 3 have also been amended to place these drawings in proper U.S. format.

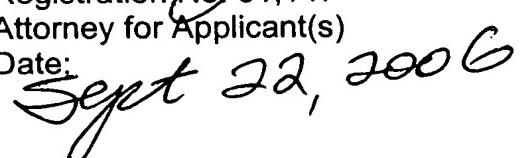
It is not believed at this time that any additional fee is due. As a precaution, the Commissioner is hereby authorized to charge to Deposit Account No. 02-2865 any additional fee required by this submission.

Respectfully submitted,



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GEAR ASSEMBLY
Tristan Richard Ghislain Davenne, John Cambridge Smith
International Application No. PCT/GB2005/001087
Dkt. No. M04B101
REPLACEMENT SHEET

1 / 2

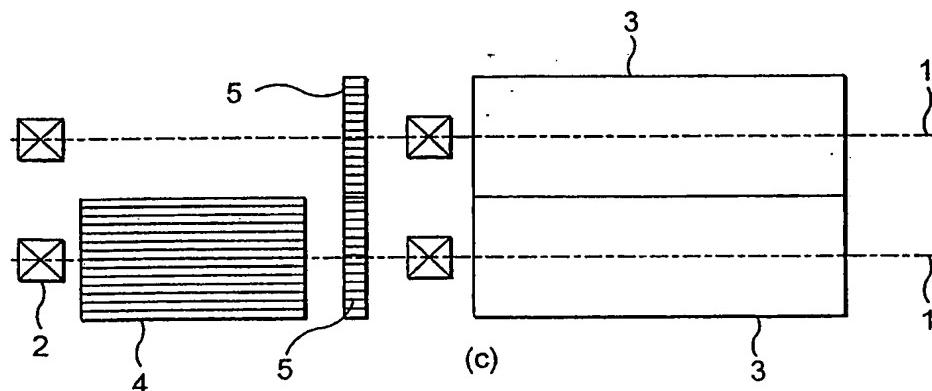
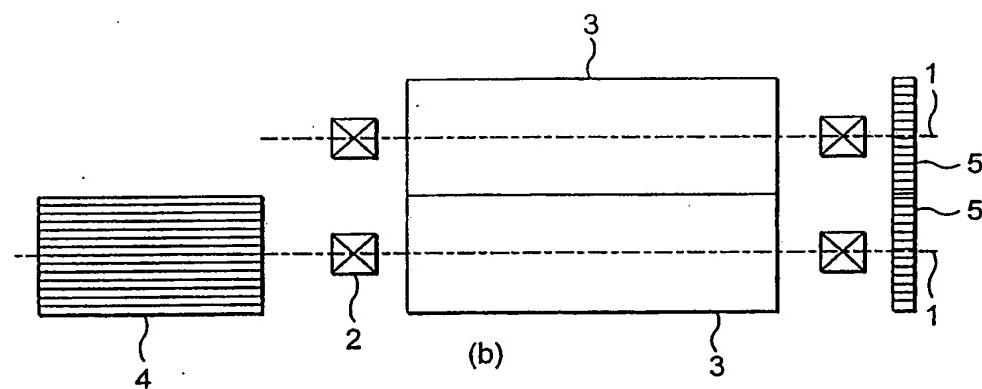
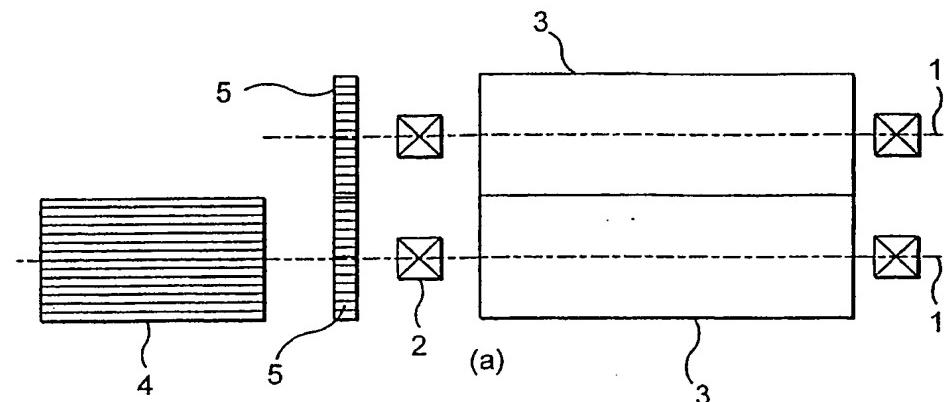


FIG. 1

(PRIOR ART)

GEAR ASSEMBLY

Tristan Richard Ghislain Davenne, John Cambridge Smith

International Application No. PCT/GB2005/001087

Dkt. No. M04B101

REPLACEMENT SHEET

2 / 2

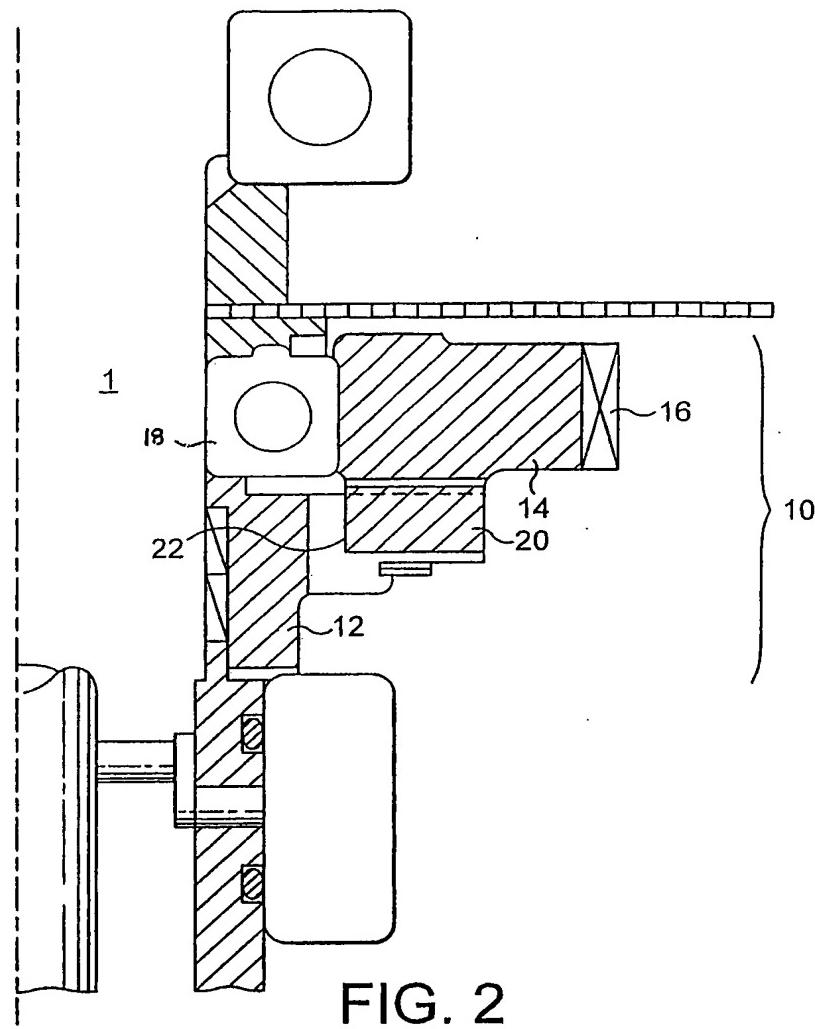


FIG. 2

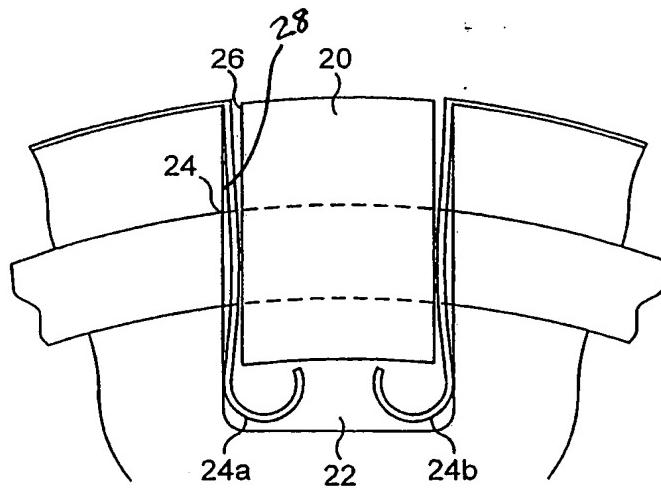


FIG. 3

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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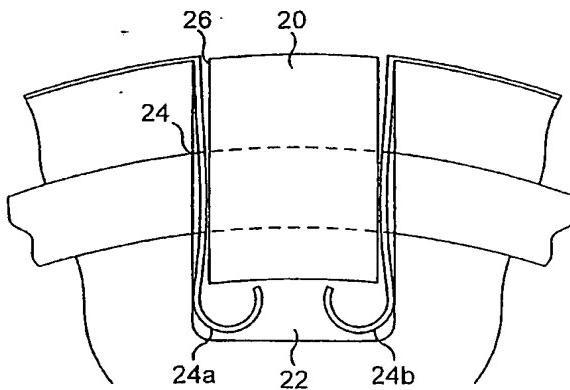
- (51) International Patent Classification⁷: **F16H 55/14, 57/00, F16D 3/52, F04C 29/00**
- (21) International Application Number: **PCT/GB2005/001087**
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- (74) Agent: BOOTH, Andrew, Steven; The Boc Group Plc, Chertsey Road, Windlesham, Surrey GU20 6HJ (GB).
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Published:

— with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: GEAR ASSEMBLY



WO 2005/093293 A1

(57) Abstract: A gear assembly for transmitting torque from one shaft to another comprises two intermeshing gears mounted on respective shafts. One of the gears comprises a hub member for receiving one of the shafts, a toothed annular member mounted for rotation with the hub member. At least one spring provided between the hub member and the annular member has stiffness capable of reducing torsional vibrations and noise induced during rotation of the gears by the eccentricity of at least one of the gears.

GEAR ASSEMBLY

The present invention relates to a gear assembly for transmitting torque from one shaft to another, and to a gear suitable for use in such an assembly. The gear
5 assembly is particularly useful for transmitting torque between shafts of a vacuum pump.

With reference to Figure 1, a known vacuum pump includes a pumping chamber through which pass a pair of parallel shafts 1 supported by bearings 2. A rotor 3 is mounted on each shaft 1 for rotation within the pumping chamber. The rotors 3 have complementary pumping profiles, which may be Roots, Northev (or "claw") or screw. In use, when a motor 4 is driving one of the shafts 1, the other shaft is rotated synchronously with that shaft by means of the meshed timing gears 5. The rotors 3 are so profiled that fluid to be pumped is drawn into an inlet of the
15 pumping chamber and exits from the pumping chamber via an outlet.

Figure 1 illustrates three different pumping configurations. In Figure 1(a), the rotors 3 are mounted between the bearings 2 and the timing gears 5 are provided at the motor-driven end of the pump. In Figure 1(b), the timing gears 5 are provided at the other end of the pump, and Figure 1(c) illustrates a configuration using cantilevered rotors.

Transmission of torque through the meshed gears 5 is affected by gear eccentricity. Gear eccentricity results in an oscillating drive torque, which would normally be constant with concentric gears. In the case of high inertia, lightly loaded, rotating machinery driven by gears with typical manufacturing eccentricity tolerances, the magnitude of the oscillating drive torque can exceed the steady state drive torque. As a result, the gears leave mesh, which can provoke high frequency tooth-to-tooth slapping, a characteristic noise frequently encountered in
25 lightly loaded rotating machinery.
30

- 2 -

Pump design has been improved to reduce friction and power consumption. Consequently the required steady state drive torque has reduced and thus rotating machinery has become increasingly prone to eccentricity induced torsional vibrations and related noise problems.

5

It is an aim of at least the preferred embodiment of the present invention to reduce such torsional vibrations and noise by accommodating typical gear eccentricities.

In one aspect, the present invention provides a gear assembly for transmitting 10 torque from one shaft to another, the gear assembly comprising two intermeshing gears mounted on respective shafts, one of the gears comprising a hub member for receiving one of the shafts, a toothed annular member mounted for rotation with the hub member, and means provided between the hub member and the annular member having a stiffness capable of reducing torsional vibrations and 15 noise induced during rotation of the gears by eccentricity of at least one of the gears.

The means for inhibiting torsional vibrations and noise preferably comprises a 20 resilient coupling between the hub member and the annular member. This coupling is preferably located between opposing surfaces of the members. In the preferred embodiment, the resilient coupling is located within a drive mechanism for transferring torque between the members. For example, one member may comprise one or more recesses each for receiving a detent of the other member 25 for transferring torque between the members, the resilient coupling being located between opposing surfaces of the or each recess and detent.

The means for inhibiting torsional vibrations and noise thus preferably comprises 30 at least one resilient member located between opposing surfaces of the members. In the preferred embodiment, a plurality of resilient members are each located between respective opposing surfaces of the members.

The resilient members may be conveniently provided by a number of springs, for example, metal torsional springs or translational springs including flat, disc and coil springs acting along a tangential line within the radius of the member.

Alternatively, repelling magnets could be used with the resulting stiffness being
5 proportional to the magnetic flux. Finally in some applications use of viscoelastic materials may be appropriate.

Providing means such as a spring between the hub member and the annular member can allow the torsional stiffness of the gear to be controlled.

10 By providing a spring between the members the inertia that is accelerated and decelerated due to eccentricity is reduced. As the gear is accelerated, the spring is designed to compress so that the shaft can remain at a constant speed. This isolation of the shaft from eccentricity-induced gear acceleration reduces the oscillations in drive torque and will increase the eccentricity at which the gears will
15 leave mesh.

In the event of an external torque other than that resulting from gear eccentricity causes the gears to leave mesh, the spring will act to absorb the impact that occurs as the gears come back into mesh and thus act to bring the assembly back
20 to the linear, in-mesh, operating region. In support of this argument, non-linear analysis of tooth-to-tooth slapping has shown that the gears can only leave mesh if the overall torsional stiffness is above a certain level. In other words, low torsional stiffness rotating machinery ('weak shafts') would always remain in mesh.

25 This aspect of the invention extends to a vacuum pump comprising at least two shafts connected together by a gear assembly as aforementioned. For example, a high-speed Roots blower vacuum pump includes Roots profile rotors rotating in a pumping chamber with a 1:1 gear ratio. Torsional vibrations between the gears can be a problem when operating at maximum speed and ultimate pressure (the
30 best vacuum achievable by the pump). The noise generated has been shown to depend on gear eccentricity, and is present with the available manufacturing gear wheel tolerances. An experimental prototype gear according to the invention

- 4 -

fitted to the driven shaft has been shown to eliminate gear tooth-to-tooth slapping with gear eccentricities that normally result in a pump prone to this noise problem.

In another aspect the present invention provides a gear for transmitting torque from one shaft to another, the gear comprising a hub member for receiving one of the shafts, a toothed annular member mounted for rotation with the hub member, and means provided between the hub member and the annular member having a stiffness capable of reducing torsional vibrations and noise induced during use by the eccentricity of the annular member.

10

A further aspect of the invention provides use of at least one spring in a gear of a gear assembly to reduce torsional vibrations and noise induced during rotation of the gears by the eccentricity of at least one of the gears.

15 Preferred features of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 illustrates schematically three known pump configurations;

20 Figure 2 is a cross-section of a gear suitable for use in any of the pumps of Figure 1; and

Figure 3 is a cross-section illustrating the mechanism for transmitting torque between the hub member and annular member of the gear of Figure 2.

25

With reference to Figure 2, a gear 10 suitable for use in any of the vacuum pumps shown in Figure 1 or in any other lightly loaded, high inertia rotating machine comprises a hub member 12 for receiving a shaft of the pump and an annular member 14 mounted for rotation with the hub member 12 and having peripheral teeth 16. The shaft received by the hub member 12 may be either a drive shaft or a driven shaft of the pump. A bearing assembly 18 is carried by the bore of the annular member 14 and the shaft.

In use, the peripheral teeth 16 of the annular member 14 are in meshing engagement with the corresponding teeth of another gear having a 1:1 gear ratio with the gear 10, similar to the timing gears 5 shown in Figure 1.

5

A drive mechanism for transmitting torque between the members 12, 14 is provided by a plurality of detents provided around a surface perpendicular to the rotational axis of one of the members which enter respective recesses provided around the facing axial surface of the other member. In the embodiment shown in 10 Figure 2, detents 20 are provided on the annular member 14 and recesses 22 are provided on the hub member 12, although this could be the other way around, with the detents being provided on the hub member and the recesses provided on the annular member.

15

As shown in Figure 3, flat springs 24a, 24b are located within each recess 22 between the facing radial surfaces 26, 28 of the detent 20 and recess 22. The springs 24a, 24b have a stiffness chosen to substantially inhibit torsional vibrations and noise induced under lightly loaded conditions by eccentricity of either the annular member 14 or of the gear meshing with the teeth 16 of the annular 20 member 14. The springs 24a, 24b also provide absorption of any tooth-to-tooth impact resulting from external disturbances.

25

Under lightly loaded conditions, as experienced by a pump operating at ultimate pressure, the transmission of torque between the members 12, 14 is through one of the springs 24a, 24b provided within each recess 22. This provides a degree of resilience necessary to accommodate any gear eccentricity.

30

In the event of the pump being subject to higher loads where a solid drive is needed to avoid compromising the phase relationship between the driving and driven shafts, the spring flattens between the facing radial surfaces 26, 28 once the angular deflection of the spring has reached a specified value above a

- 6 -

predetermined drive torque. This provides the necessary solid drive between the radial faces 26, 28.

Whilst in this embodiment flat springs have been used to control torsional stiffness,
5 tangentially mounted disc springs or coil springs could be used instead.

Alternatively, repelling magnets could be used, with the resulting torsional stiffness being proportional to the magnetic flux. In some applications, use of viscoelastic materials may be appropriate.

CLAIMS

1. A gear assembly for transmitting torque from one shaft to another, the gear assembly comprising two intermeshing gears mounted on respective shafts, one of the gears comprising a hub member for receiving one of the shafts, a toothed annular member mounted for rotation with the hub member, and means provided between the hub member and the annular member having a stiffness capable of reducing torsional vibrations and noise induced during rotation of the gears by the eccentricity of at least one of the gears.
2. A gear assembly according to Claim 1, wherein the means for reducing torsional vibrations and noise comprises means for increasing the critical eccentricity of the gear.
3. A gear assembly according to any preceding claim, wherein the means for reducing torsional vibrations and noise comprises a resilient coupling between the hub member and the annular member.
4. A gear assembly according to any preceding claim, wherein the means for reducing torsional vibrations and noise is located between a radial surface of the hub member and an opposing radial surface of the annular member.
5. A gear assembly according to any preceding claim, wherein the means for reducing torsional vibrations and noise is located within a drive mechanism for transferring torque between the hub member and the annular member.
6. A gear assembly according to Claim 5, wherein one of the hub member and the annular member comprises a recess for receiving a

detent of the other of the hub member and the annular member for transferring torque between the hub member and the annular member, the means for reducing torsional vibrations and noise being located between opposing surfaces of the recess and the detent.

- 5 7. A gear assembly according to Claim 6, wherein said one of the hub member and the annular member comprises a plurality of said recesses each for receiving a respective detent of the other of the hub member and the annular member, the means for reducing torsional vibrations and noise being located between opposing surfaces of each recess and detent.
- 10 15. 8. A gear assembly according to any preceding claim, wherein the means for inhibiting torsional vibrations and noise comprises at least one resilient member located between opposing surfaces of the hub member and the annular member.
- 15 20. 9. A gear assembly according to Claim 8, wherein the means for inhibiting torsional vibrations and noise comprises a plurality of resilient members each located between respective opposing surfaces of the hub member and the annular member.
- 20 25. 10. A gear assembly according to Claim 9, wherein each resilient member comprises a spring for providing torsional resistance.
- 25 30. 11. A gear assembly according to Claim 9, wherein each resilient member comprises a plurality of springs for providing torsional resistance.
- 30 12. A gear assembly according to Claim 9, wherein each resilient member comprises a viscoelastic member.

- 9 -

13. A gear assembly according to any of Claims 1 to 7, wherein the means for reducing torsional vibrations and noise comprises mutually repelling magnets provided on opposing surfaces of the hub member and the annular member.
5
14. A gear assembly according to any preceding claim, wherein the means for reducing torsional vibrations and noise is arranged to maintain the phase relationship between the shafts.
- 10 15. A gear assembly according to Claim 14, wherein the means for reducing torsional vibrations and noise is arranged to permit a solid drive to be established between the hub member and the annular member above a predetermined drive torque.
- 15 16. A vacuum pump comprising at least two shafts connected together by a gear assembly according to any preceding claim.
17. A gear for transmitting torque from one shaft to another, the gear comprising a hub member for receiving one of the shafts, a toothed annular member mounted for rotation with the hub member, and means provided between the hub member and the annular member having a stiffness capable of reducing torsional vibrations and noise induced during use by eccentricity of the annular member.
20
- 25 18. Use of at least one spring in a gear of a gear assembly to reduce torsional vibrations and noise induced during rotation of the gears by eccentricity of at least one of the gears.

1 / 2

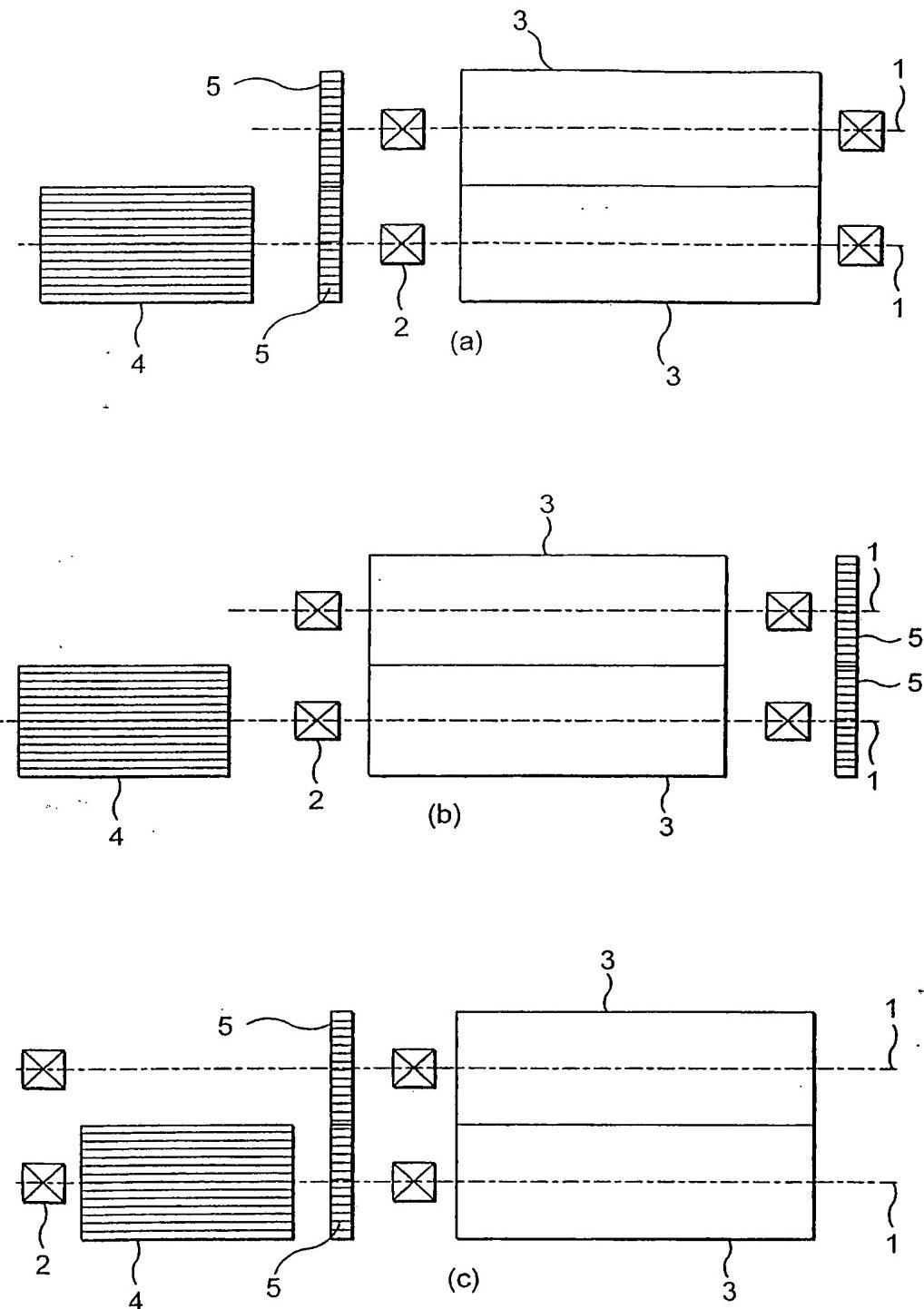


FIG. 1

2 / 2

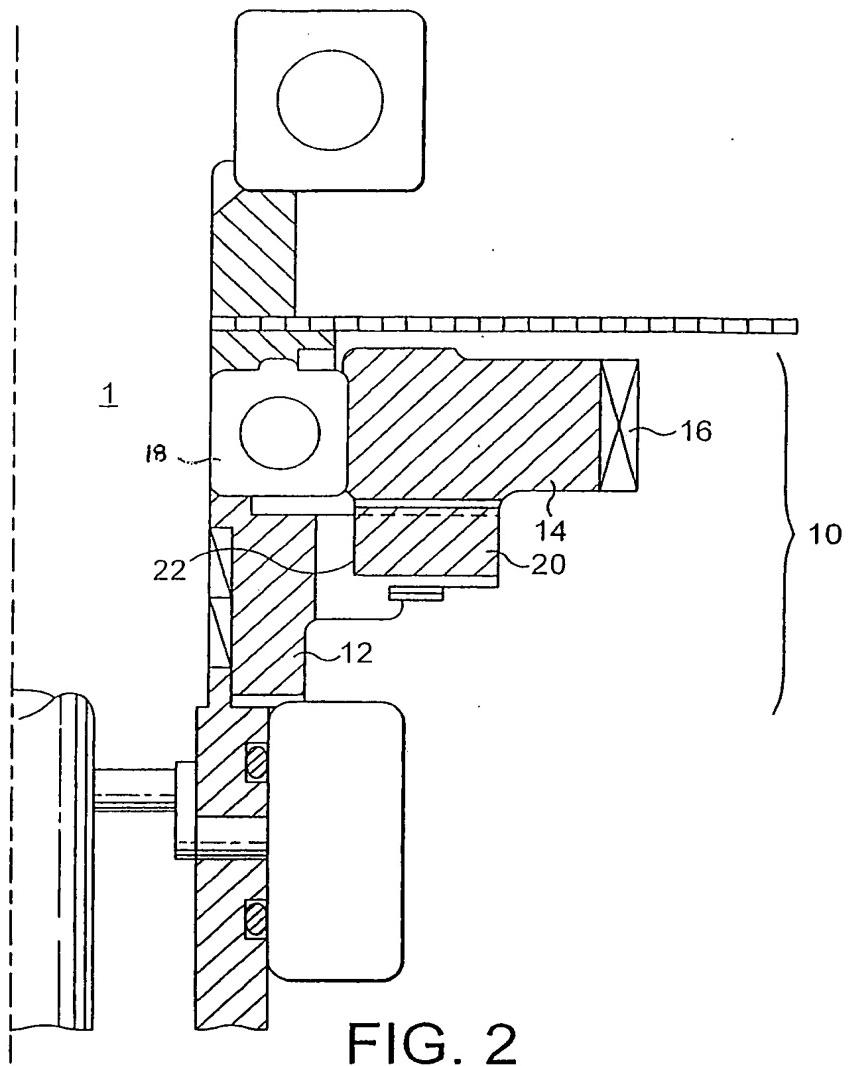


FIG. 2

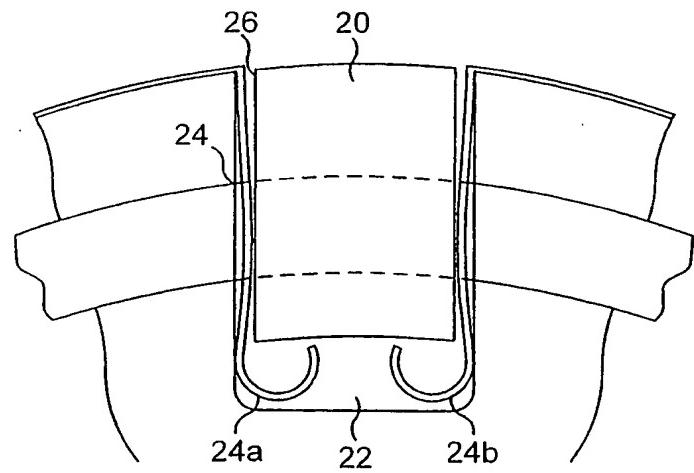


FIG. 3

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB2005/001087

A. CLASSIFICATION OF SUBJECT MATTER
 IPC 7 F16H55/14 F16H57/00 F16D3/52 F04C29/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 IPC 7 F16D F16H F04C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 344 945 A (EATON CORPORATION) 6 December 1989 (1989-12-06) claim 1; figures 2-6 -----	1-3, 5, 8, 14, 16-18
X	PATENT ABSTRACTS OF JAPAN vol. 2003, no. 04, 2 April 2003 (2003-04-02) & JP 2002 349672 A (MITSUBISHI MOTORS CORP), 4 December 2002 (2002-12-04) abstract; figures 1,3 -----	1-9, 12, 14-17
X	US 86 533 A (JOHN HAFFNER) 2 February 1869 (1869-02-02) figure 5 -----	1-5, 8, 14, 17, 18
X	US 5 692 410 A (FENELON ET AL) 2 December 1997 (1997-12-02) the whole document -----	1-11, 14, 17, 18
		-/-

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

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- "&" document member of the same patent family

Date of the actual completion of the international search

10 June 2005

Date of mailing of the international search report

22/06/2005

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Fax: (+31-70) 340-3016

Authorized officer

Meyer, T

INTERNATIONAL SEARCH REPORT

Int'l. Application No

PCT/GB2005/001087

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	BE 488 019 A (STAATSMIJNEN NEDERLAND) 15 April 1949 (1949-04-15) page 4, line 2 - line 29; figures 1-3 -----	1-8, 14, 17, 18
X	US 5 259 261 A (MICHEL ET AL) 9 November 1993 (1993-11-09) column 2, line 46 - line 62 -----	1-5, 8, 14, 17, 18
X	EP 0 987 471 A (BORG-WARNER AUTOMOTIVE, INC) 22 March 2000 (2000-03-22) paragraph '0034! - paragraph '0053! paragraph '0051!; figure 5 -----	1-11, 14, 17, 18
X	US 3 991 818 A (WAGNER ET AL) 16 November 1976 (1976-11-16) the whole document -----	15 1-5, 8-12, 14, 17, 18
X	DE 29 41 117 A1 (FABBRICA ITALIANA MAGNETI MARELLI S.P.A) 24 April 1980 (1980-04-24) the whole document -----	1, 17, 18
X	DE 34 03 259 C1 (BROSE FAHRZEUGTEILE GMBH & CO KG, 8630 COBURG, DE) 14 August 1985 (1985-08-14) the whole document -----	1, 17, 18
X	US 5 787 755 A (PERIOU ET AL) 4 August 1998 (1998-08-04) the whole document -----	1, 17, 18
X	SU 1 078 159 A1 (VOROSHILOVGRADSKIJ MASHINOSTROYELNYJ INSTITUT) 7 March 1984 (1984-03-07) figures 1,2 -----	1, 13, 17
A	DE 101 14 079 A1 (CARL FREUDENBERG KG) 2 October 2002 (2002-10-02) column 4, line 2 - line 8; figure 1 -----	13
A	US 5 893 355 A (GLOVER ET AL) 13 April 1999 (1999-04-13) the whole document -----	1, 15-18

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inte...nal Application No

PCT/GB2005/001087

Patent document cited in search report		Publication date		Patent family member(s)	Publication date
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US 5787755	A	04-08-1998	FR CN EP JP MX	2699621 A1 1094115 A 0607718 A1 6323398 A 9308007 A1	24-06-1994 26-10-1994 27-07-1994 25-11-1994 31-08-1994
SU 1078159	A1	07-03-1984		NONE	
DE 10114079	A1	02-10-2002		NONE	
US 5893355	A	13-04-1999		NONE	

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Application Number	10/594,260
Filing Date	September 25, 2006
First Named Inventor	DAVENNE et al.
Title	GEAR ASSEMBLY
Art Unit	
Examiner Name	
Attorney Docket Number	M04B101

I hereby revoke all previous powers of attorney given in the above-identified application.

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Applicant/Inventor.

Assignee of record of the entire interest. See 37 CFR 3.71.
Statement under 37 CFR 3.73(b) is enclosed. (Form PTO/SB/96)

SIGNATURE of Applicant or Assignee of Record

Signature	Date
Name	TRISTAN RICHARD GHISLAIN DAVENNE
Title and Company	Telephone

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below*.

*Total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

ASSIGNMENT

WHEREAS, I/We, Tristan Richard Ghislain Davenne and John Cambridge Smith, a citizen of/ citizens of the United Kingdom, residing at 5 Adelaide Square, Shoreham-by-Sea, West Sussex, BN43 6LN, United Kingdom; and Northpoint, The Driftway, Upper Beeding, Steyning, West Sussex, BN44 3JX, United Kingdom, have invented certain new and useful improvements in GEAR ASSEMBLY for which I/We have made application for Letters Patent of the United States, which application may be identified in the United States Patent and Trademark Office as Serial No. 10/594,260, filed September 25, 2006; which application claims priority from International Application No. PCT/GB2005/001087, filed March 22, 2005; and,

WHEREAS, The BOC Group plc, an English Company of Chertsey Road, Windlesham, Surrey GU20 6HJ, England, is desirous of obtaining the entire right, title and interest in, to and under the said improvements and the said application:

NOW, THEREFORE, in consideration of the sum of One Dollar (\$1.00) to me/us in hand paid, and other good and valuable consideration, the receipt of which is hereby acknowledged, I/WE, the said Tristan Richard Ghislain Davenne and John Cambridge Smith have sold, assigned, transferred and set over, and by these presents do hereby sell, assign, transfer and set over, unto the said **The BOC Group plc**, its successors, legal representatives and assigns, the entire right, title and interest in, to and under the invention, the said improvements, and the said application, all applications derived therefrom and all continuing prosecution applications, conversions, divisions, renewals and continuations thereof, and all Letters Patent of the United States which may be granted thereon and all reissues and extensions thereof, and all applications for Letters Patent or Inventor's Certificates which may hereafter be filed for said improvements in any country or countries foreign to the United States, and all Letters Patent or Inventor's Certificates which may be granted for said improvements in any country or countries foreign to the United States and all extensions, renewals and reissues thereof; and I/We hereby authorize and request the Commissioner of Patents of the United States, and any Official of any country or countries foreign to the United States, whose duty it is to issue patents on applications as aforesaid, to issue all Letters Patent for said improvements to the said **The BOC Group plc**, its successors, legal representatives and assigns, in accordance with the terms of this instrument.

I/WE HEREBY covenant that I/We have full right to convey the entire interest herein assigned, and that I/WE have not executed, and will not execute, any agreement in conflict herewith.

AND I/WE HEREBY further covenant and agree that I/We will communicate to the said **The BOC Group plc**, its successors, legal representatives and assigns, any facts known to me/us respecting said invention and said improvements, and testify in any legal proceeding, sign all lawful papers, execute all continuing prosecution, divisional, continuing, reexamination and reissue applications, make all rightful oaths, and generally do everything possible to aid the said **The BOC Group plc**, its successors, legal representatives and assigns, to obtain and enforce proper patent protection for said inventions and improvements in all countries.

<u>Date</u>	<u>Assignor</u>	<u>Witnessed By:</u>
	Tristan Richard Ghislain Davenne	At: _____ _____
	John Cambridge Smith	At: _____ _____



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To: Lee,Betty
Subject: RE: Tristan Davenne

Betty

In answer to your query, the address that HR have for him is:

15 Chapel Road
Epping
Essex
CM16 5DS

However, searches on the internet indicate that he lives in Sussex, which indicates that the HR address may be more out of date than the address we have.

I suggest you try both addresses, but he flatly refused to sign anything before he left BOC.

Good luck!

Julia

Julia Tribe | Intellectual Property Formalities Administrator | Edwards
Tel: +44 (0)1293 603341 | Fax: +44 (0)1293 407451 | julia.tribe@edwardsvacuum.com
Manor Royal, Crawley, West Sussex, RH10 9LW, UK | www.edwardsvacuum.com

Edwards Ltd | Registered in England and Wales No. 6124750
Registered office: Manor Royal, Crawley, West Sussex RH10 9LW

From: Tribe,Julia
Sent: 14 September 2007 12:03
To: Lee,Betty
Cc: Nicholes,Kristi
Subject: Tristan Davenne

Hi Betty

I hope you had a good holiday.

The last known address for Tristan Davenne is as on CPI:

5 Adelaide Square
Shoreham-by-Sea
West Sussex BN43 6LN

Good luck!



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USA

VIA DHL

October 9, 2007

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Mr. Tristan Richard Ghislain Davenne
15 Chapel Road
Epping
Essex CM16 5DS
United Kingdom

RE: U.S. Patent Application No. 10/594,260
Filing Date: September 25, 2006
Title: GEAR ASSEMBLY
Dkt. No. M04B101

Dear Mr. Davenne:

Enclosed please find a copy of the above-referenced patent application for the invention of which you are a co-inventor. Also enclosed for your execution is (a) an inventor's Declaration to be signed (and dated) by you in blue ink; (b) an Assignment which you should sign on the same date that you sign (and date) the Declaration; and (c) a Power of Attorney and Correspondence Address Indication Form which you should also please sign and date.

Please review the application carefully and make sure that you agree with its contents prior to executing the Declaration.

If there are no changes to be made, please read the Declaration carefully, paying particular attention to the fact that, by signing the Declaration, you acknowledge the following:

- a) To the best of your knowledge, you are the first and true inventor of the subject matter of the patent application.
- b) You owe the highest duty of candor and good faith in your dealings with the Patent and Trademark Office, and in discharge of this duty, you must disclose to the Patent and Trademark Office any information of which you are aware that is "material to examination of this application" as defined in the attached 37 CFR § 1.56. Such information is material when, at least in part, there is a substantial likelihood that a patent examiner would consider it important in deciding whether the subject matter of the present application is patentable.

After these steps have been taken, please sign (and date) the Declaration.

The Assignment should be signed by you and witnessed at the same time that you sign and date the Declaration.

The Power of Attorney and Correspondence Address Indication Form should be signed and dated by you.

Please return the application copy with the signed Declaration, signed Assignment and signed Power of Attorney. The extra copy of the application is for your records.

I look forward to receiving these papers as soon as possible.

On behalf of Edwards Vacuum, Inc., thank you once for your submittal of the above-referenced invention record on which the patent application is based. If you have any concerns or questions, please do not hesitate to contact me.

Best Regards,



Kristi Nicholes | Patent Agent | Edwards

Tel: 1 973 285 3309 | Mobile: 1 862 812 4944 | kristi.nicholes@edwardsvacuum.com

Enclosures

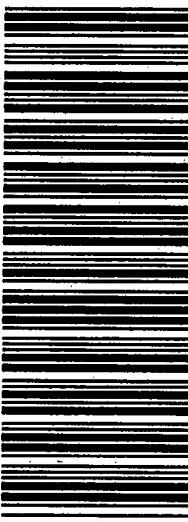
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PATENT APPLICATION
(37 CFR 1.63)**

Declaration Submitted With Initial Filing

OR

Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)

Attorney Docket Number	M04B101
First Named Inventor	DAVENNE et al.
<i>COMPLETE IF KNOWN</i>	
Application Number	10/594,260
Filing Date	September 25, 2006
Art Unit	
Examiner Name	

I hereby declare that:

Each inventor's residence, mailing address, and citizenship are as stated below next to their name.

I believe the inventor(s) named below to be the original and first inventor(s) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

GEAR ASSEMBLY

(Title of the Invention)

the specification of which

is attached hereto

OR

was filed on (MM/DD/YYYY) 03/22/2005 as United States Application Number or PCT International

Application Number PCT/GB2005/001087 and was amended on (MM/DD/YYYY) (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or (f), or 365(b) of any foreign application(s) for patent, inventor's or plant breeder's rights certificate(s), or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent, inventor's or plant breeder's rights certificate(s), or any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached? YES	Certified Copy Attached? NO
0406887.0	GB	03/26/2004	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>

Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

[Page 1 of 2]

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 21 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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DECLARATION — Utility or Design Patent Application

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

NAME OF SOLE OR FIRST INVENTOR:	<input type="checkbox"/> A petition has been filed for this unsigned inventor		
Given Name (first and middle [if any]) TRISTAN RICHARD GHISLAIN	Family Name or Surname DAVENNE		
Inventor's Signature			Date
Residence: City EPPING, ESSEX	State	Country UNITED KINGDOM	Citizenship UNITED KINGDOM
Mailing Address 15 CHAPEL ROAD			
City EPPING, ESSEX	State	Zip CM16 5DS	Country UNITED KINGDOM
<input checked="" type="checkbox"/> Additional inventors or a legal representative are being named on the <u>one</u> supplemental sheet(s) PTO/SB/02A or 02LR attached hereto.			

§ 1.56 DUTY TO DISCLOSE INFORMATION MATERIAL TO PATENTABILITY. (Added 3/16/92)

(a) A patent by its very nature is affected with a public interest. The public interest is best served, and the most effective patent examination occurs when, at the time an application is being examined, the Office is aware of and evaluates the teachings of all information material to patentability. Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability as defined in this section. The duty to disclose information exists with respect to each pending claim until the claim is canceled or withdrawn from consideration, or the application becomes abandoned. Information material to the patentability of a claim that is cancelled or withdrawn from consideration need not be submitted if the information is not material to the patentability of any claim remaining under consideration in the application. There is no duty to submit information which is not material to the patentability of any existing claim. The duty to disclose all information known to be material to patentability is deemed to be satisfied if all information known to be material to patentability of any claim issued in a patent was cited by the Office or submitted to the Office in the manner prescribed by §§ 1.97(b)-(d) and 1.98. However, no patent will be granted on an application in connection with which fraud on the Office was practiced or attempted or the duty of disclosure was violated through bad faith or intentional misconduct. The Office encourages applicants to carefully examine: (Added 3/16/92)

- (1) prior art cited in search reports of a foreign patent office in a counterpart application, and (Added 3/16/92)

- (2) the closest information over which individuals associated with the filing or prosecution of a patent application believe any pending claim patentability defines, to make sure that any material information contained therein is disclosed to the Office. (Added 3/16/92)

(b) Under this section, information is material to patentability when it is not cumulative to information already of record or being made of record in the application, and (Added 3/16/92)

(c) Individuals other than the attorney, agent or inventor may comply with this section by disclosing information to the attorney, agent, or inventor. (Added 3/16/92)

(d) In any continuation-in-part application, the duty under this section includes the duty to disclose to the Office all information known to the person to be material to patentability, as defined in paragraph (b) of this section, which became available between the filing date of the prior application and the national or PCT international filing date of the prior continuation-in-part application. (Added 11/7/00).

- (1) It establishes, by itself or in combination with other information, a prima facie case of unpatentability of a claim; or (Added 3/16/92)
- (2) It refutes, or is inconsistent with, a position the applicant takes in: (Added 3/16/92)
- (i) Opposing an argument of unpatentability relied on by the Office, or (Added 3/16/92)
 - (ii) Asserting an argument of patentability. (Added 3/16/92)

A prima facie case of unpatentability is established when the information compels a conclusion that a claim is unpatentable under the preponderance of evidence, burden-of-proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any consideration is given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability. (Added 3/16/92)

(c) Individuals associated with the filing or prosecution of a patent application within the meaning of this section are: (Added 3/16/92)

- (1) Each inventor named in the application: (Added 3/16/92)

- (2) Each attorney or agent who prepares or prosecutes the application; and (Added 3/16/92)

- (3) Every other person who is substantively involved in the preparation or prosecution of the application and who is associated with the inventor, with the assignee or with anyone to whom there is an obligation to assign the application. (Added 3/16/92)

(d) Individuals other than the attorney, agent or inventor may comply with this section by disclosing information to the attorney, agent, or inventor. (Added 3/16/92)

(e) In any continuation-in-part application, the duty under this section includes the duty to disclose to the Office all information known to the person to be material to patentability, as defined in paragraph (b) of this section, which became available between the filing date of the prior application and the national or PCT international filing date of the prior continuation-in-part application. (Added 11/7/00).

International Application No.
PCT/GB2005/001087

National Stage
Preliminary Amendment

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: DAVENNE et al. Attorney Docket No.: M04B101
International Application No.: PCT/GB2005/001087 Group Art Unit:
International Application Filing Date: March 22, 2005
National Application Filed: Concurrently Herewith
Title: GEAR ASSEMBLY

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

PRELIMINARY AMENDMENT

37 C.F.R. § 1.115

Dear Sir:

Prior to examining the above-identified application, please amend the above-identified application as follows:

Amendments to the Specification begin on page 2.

Amendments to the Claims begin on page 6.

Amendments to the Drawings begin on page 9.

Remarks begin on page 10.

IN THE SPECIFICATION

Please amend page 1 by inserting the following heading between the title of the invention and the first paragraph:

"FIELD OF THE INVENTION"

Please amend page 1 by inserting the following heading between the first and second paragraphs:

"BACKGROUND OF THE INVENTION"

Please amend page 2 by inserting the following heading on line 8:

"SUMMARY OF THE INVENTION"

Please amend page 4 by inserting the following heading on line 14:

"BRIEF DESCRIPTION OF THE DRAWINGS"

Please amend page 4 by inserting the following heading on line 25:

"DETAILED DESCRIPTION OF THE INVENTION"

Please amend page 7 by inserting the following language between the "CLAIMS" heading and claim 1:

"I/We claim:"

Please amend pages 2-4 by deleting the following text beginning on page 2 line 20 and ending on page 4 line 2 as follows:

~~"In the preferred embodiment, the resilient coupling is located within a drive mechanism for transferring torque between the members. For example, one member may comprise one or more recesses each for receiving a detent of the other member for transferring torque between the members, the resilient coupling being located between opposing surfaces of the or each recess and detent.~~

~~The means for inhibiting torsional vibrations and noise thus preferably comprises at least one resilient member located between opposing surfaces of the~~

members. In the preferred embodiment, a plurality of resilient members are each located between respective opposing surfaces of the members.

The resilient members may be conveniently provided by a number of springs, for example, metal torsional springs or translational springs including flat, disc and coil springs acting along a tangential line within the radius of the member. Alternatively, repelling magnets could be used with the resulting stiffness being proportional to the magnetic flux. Finally in some applications use of viscoelastic materials may be appropriate.

Providing means such as a spring between the hub member and the annular member can allow the torsional stiffness of the gear to be controlled. By providing a spring between the members the inertia that is accelerated and decelerated due to eccentricity is reduced. As the gear is accelerated, the spring is designed to compress so that the shaft can remain at a constant speed. This isolation of the shaft from eccentricity induced gear acceleration reduces the oscillations in drive torque and will increase the eccentricity at which the gears will leave mesh.

In the event of an external torque other than that resulting from gear eccentricity causes the gears to leave mesh, the spring will act to absorb the impact that occurs as the gears come back into mesh and thus act to bring the assembly back to the linear, in-mesh, operating region. In support of this argument, non-linear analysis of tooth-to-tooth slapping has shown that the gears can only leave mesh if the overall torsional stiffness is above a certain level. In other words, low torsional stiffness rotating machinery ('weak shafts') would always remain in mesh.

This aspect of the invention extends to a vacuum pump comprising at least two shafts connected together by a gear assembly as aforementioned. For example, a high-speed Roots blower vacuum pump includes Roots profile rotors rotating in a pumping chamber with a 1:1 gear ratio. Torsional vibrations between the gears can be a problem when operating at maximum speed and ultimate pressure (the best vacuum achievable by the pump). The noise generated has been shown to depend on gear eccentricity, and is present with the available manufacturing gear wheel tolerances. An experimental prototype gear according to the invention fitted to the driven shaft has been shown to eliminate gear tooth-to-tooth slapping with gear eccentricities that normally result in a pump prone to this noise problem."

Please amend page 4 beginning on line 30 as follows:

"...teeth 16. There is a resilient coupling located between the hub member 12 and the annular member 14. In the preferred embodiment, the resilient coupling is located within a drive mechanism for transferring torque between the members. For example, one member may comprise one or more recesses each for receiving a detent of the other member for transferring torque between the members, the resilient coupling being located between opposing surfaces of the or each recess and detent. The means for inhibiting torsional vibrations and noise thus preferably comprises at least one resilient member located between opposing surfaces of the members. In the preferred embodiment, a plurality of resilient members are each located between respective opposing surfaces of the members. The shaft received by the hub member 12 may be either a drive shaft or a driven shaft of the pump. A bearing assembly 18 is carried by the bore of the annular member 14 and the shaft."

Please amend page 5 beginning on line 14 by inserting the following text:

"The resilient members may be conveniently provided by a number of springs, for example, metal torsional springs or translational springs including flat, disc and coil springs acting along a tangential line within the radius of the member. Alternatively, repelling magnets could be used with the resulting stiffness being proportional to the magnetic flux.

Providing means such as a spring between the hub member and the annular member can allow the torsional stiffness of the gear to be controlled. By providing a spring between the members the inertia that is accelerated and decelerated due to eccentricity is reduced. As the gear is accelerated, the spring is designed to compress so that the shaft can remain at a constant speed. This isolation of the shaft from eccentricity-induced gear acceleration reduces the oscillations in drive torque and will increase the eccentricity at which the gears will leave mesh.

As shown in Figure 3, flat springs 24a, 24b are located within each recess 22 between the facing radial surfaces 26, 28 of the detent 20 and recess 22. The springs 24a, 24b have a stiffness chosen to substantially..."

Please amend page 6 beginning on line 9 as follows:

"In the event of an external torque other than that resulting from gear eccentricity causes the gears to leave mesh, the spring will act to absorb the impact that occurs as the gears come back into mesh and thus act to bring the assembly back to the linear, in-mesh, operating region. In support of this argument, non-linear analysis of tooth-to-tooth slapping has shown that the gears can only leave mesh if the overall torsional stiffness is above a certain level. In other words, low torsional stiffness rotating machinery ('weak shafts') would always remain in mesh.

This aspect of the invention extends to a vacuum pump comprising at least two shafts connected together by a gear assembly as aforementioned. For example, a high-speed Roots blower vacuum pump includes Roots profile rotors rotating in a pumping chamber with a 1 :1 gear ratio. Torsional vibrations between the gears can be a problem when operating at maximum speed and ultimate pressure (the best vacuum achievable by the pump). The noise generated has been shown to depend on gear eccentricity, and is present with the available manufacturing gear wheel tolerances. An experimental prototype gear according to the invention fitted to the driven shaft has been shown to eliminate gear tooth-to-tooth slapping with gear eccentricities that normally result in a pump prone to this noise problem.

While the foregoing description and drawings represent the preferred embodiments of the present invention, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the true spirit and scope of the present invention."

IN THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in the application.

LISTING OF CLAIMS

1. (currently amended) A gear assembly for transmitting torque from one shaft to another, ~~the gear assembly comprising:~~ two intermeshing gears mounted on respective shafts, one of the gears comprising a hub member for receiving one of the shafts, ~~;~~ a toothed annular member mounted for rotation with the hub member, ~~;~~ and means for reducing torsional vibrations and noise provided between the hub member and the annular member and having a stiffness capable of reducing torsional vibrations and noise induced during rotation of the gears by the eccentricity of at least one of the gears.
2. (currently amended) ~~A~~The gear assembly according to ~~Claim~~ 1, wherein the means for reducing torsional vibrations and noise comprises means for increasing the critical eccentricity of the gear.
3. (currently amended) ~~A~~The gear assembly according to ~~any preceding claim 1,~~ wherein the means for reducing torsional vibrations and noise comprises a resilient coupling between the hub member and the annular member.
4. (currently amended) ~~A~~The gear assembly according to ~~any preceding claim 1,~~ wherein the means for reducing torsional vibrations and noise is located between a radial surface of the hub member and an opposing radial surface of the annular member.
5. (currently amended) ~~A~~The gear assembly according to ~~any preceding claim 1,~~ wherein the means for reducing torsional vibrations and noise is located

within a drive mechanism for transferring torque between the hub member and the annular member.

6. (currently amended) A-The gear assembly according to Claim 5, wherein one of the hub member and the annular member comprises a recess for receiving a detent of the other of the hub member and the annular member for transferring torque between the hub member and the annular member, the means for reducing torsional vibrations and noise being located between opposing surfaces of the recess and the detent.
7. (currently amended) A-The gear assembly according to Claim 6, wherein said one of the hub member and the annular member comprises a plurality of said recesses each for receiving a respective detent of the other of the hub member and the annular member, the means for reducing torsional vibrations and noise being located between opposing surfaces of each recess and detent.
8. (currently amended) A-The gear assembly according to any preceding claim 1, wherein the means for inhibiting torsional vibrations and noise comprises at least one resilient member located between opposing surfaces of the hub member and the annular member.
9. (currently amended) A-The gear assembly according to Claim 8, wherein the means for inhibiting torsional vibrations and noise comprises a plurality of resilient members each located between respective opposing surfaces of the hub member and the annular member.
10. (currently amended) A-The gear assembly according to Claim 9, wherein each resilient member comprises a spring for providing torsional resistance.
11. (currently amended) A-The gear assembly according to Claim 9, wherein each resilient member comprises a plurality of springs for providing torsional resistance.

12. (currently amended) A The gear assembly according to Claim 9, wherein each resilient member comprises a viscoelastic member.
13. (currently amended) A The gear assembly according to any of Claims 1 to 7, wherein the means for reducing torsional vibrations and noise comprises mutually repelling magnets provided on opposing surfaces of the hub member and the annular member.
14. (currently amended) A The gear assembly according to any preceding claim 1, wherein the means for reducing torsional vibrations and noise is arranged to maintain the phase relationship between the shafts.
15. (currently amended) A The gear assembly according to Claim 14, wherein the means for reducing torsional vibrations and noise is arranged to permit a solid drive to be established between the hub member and the annular member above a predetermined drive torque.
16. (currently amended) A vacuum pump comprising at least two shafts connected together by a gear assembly comprising two intermeshing gears mounted on respective shafts, one of the gears comprising a hub member for receiving one of the shafts;
a toothed annular member mounted for rotation with the hub member; and
means for reducing torsional vibrations and noise provided between the hub member and the annular member and having a stiffness capable of reducing torsional vibrations and noise induced during rotation of the gears by the eccentricity of at least one of the gears, according to any preceding claim.
17. (currently amended) A gear for transmitting torque from one shaft to another, the gear comprising;
a hub member for receiving one of the shafts;
a toothed annular member mounted for rotation with the hub member; and

means provided between the hub member and the annular member having a stiffness capable of reducing torsional vibrations and noise induced during use by eccentricity of the annular member.

18. Cancelled

IN THE DRAWINGS

Fig. 1 has been amended to include a "Prior Art" legend.

Fig. 3 has been amended to included identifier "28".

REMARKS

This application is being filed concurrently with entry into the National Stage (Chapter 1) of International Application No. PCT/GB2005/001087 which claims the priority of Great Britain Patent Application No. 0406887.0.

This Preliminary Amendment was considered when calculating the filing fee. Accordingly, the total number of claims specified on the Transmittal Letter is 17 and the number of independent claims is 3.

The Specification has been amended to place the application in proper U.S. format. Headings have been added to each section. In addition, the text deleted from page 2 lines 20-30 has been inserted on page 4 line 30. The text deleted from page 3 lines 1-15 has been inserted on page 5 line 14. Finally, the text deleted from page 3 lines 17-32 and page 4 lines 1-2 has been inserted on page 6 line 10. No new matter has been introduced.

Claims 1-17 remain in the application and claim 18 has been cancelled. Claims 1-17 have been amended to eliminate multiple dependencies in these claims and to place the claims in proper U.S. format. Figures 1 and 3 have also been amended to place these drawings in proper U.S. format.

It is not believed at this time that any additional fee is due. As a precaution, the Commissioner is hereby authorized to charge to Deposit Account No. 02-2865 any additional fee required by this submission.

Respectfully submitted,


Ira Lee Zebrak
Registration No. 31,147
Attorney for Applicant(s)
Date:
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GEAR ASSEMBLY
Tristan Richard Ghislain Davenne, John Cambridge Smith
International Application No. PCT/GB2005/001087
Dkt. No. M04B101
REPLACEMENT SHEET

1 / 2

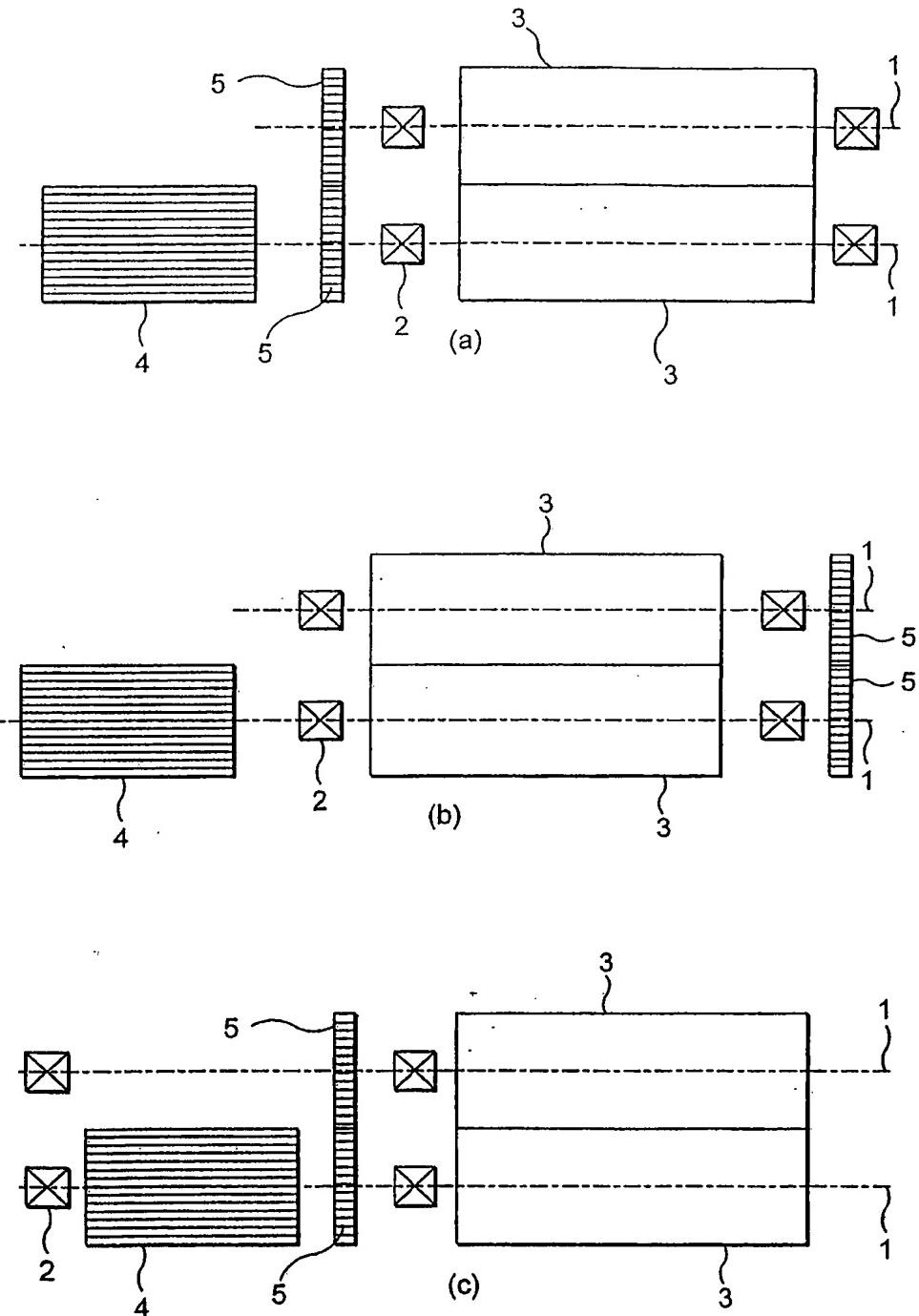


FIG. 1

(PRIOR ART)

GEAR ASSEMBLY
Tristan Richard Ghislain Davenne, John Cambridge Smith
International Application No. PCT/GB2005/001087
Dkt. No. M04B101
REPLACEMENT SHEET

2 / 2

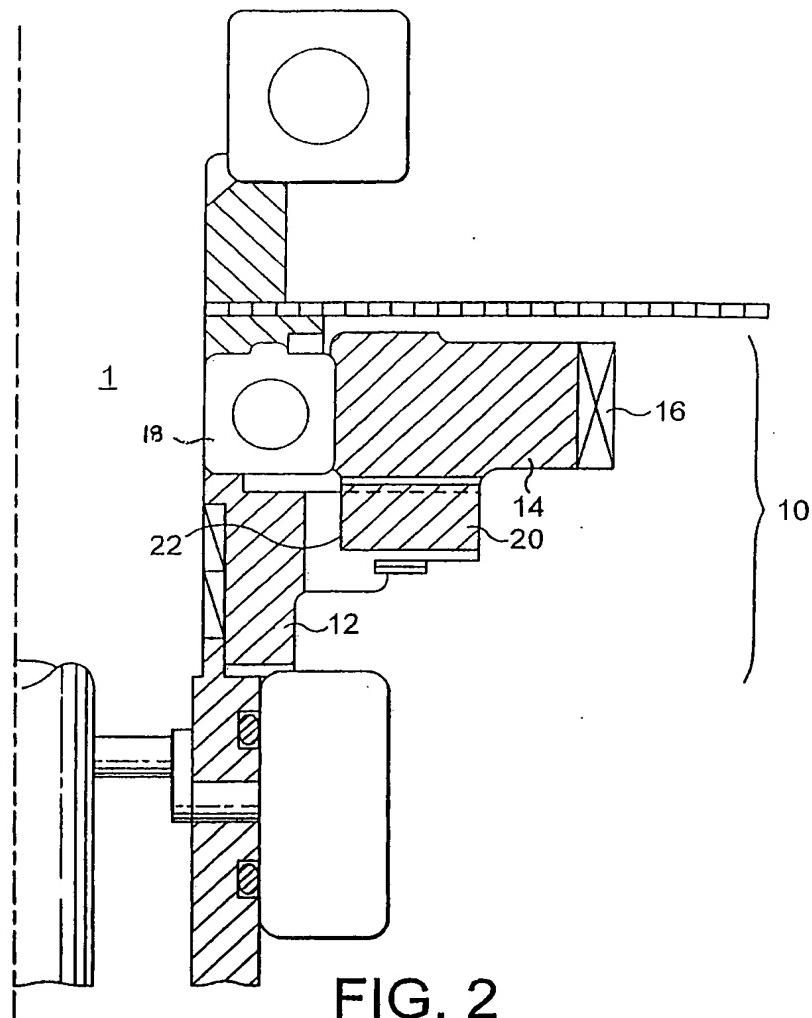


FIG. 2

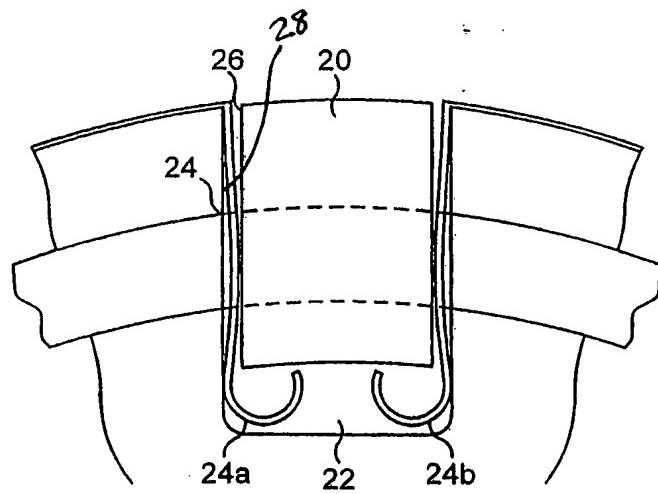


FIG. 3

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization International Bureau



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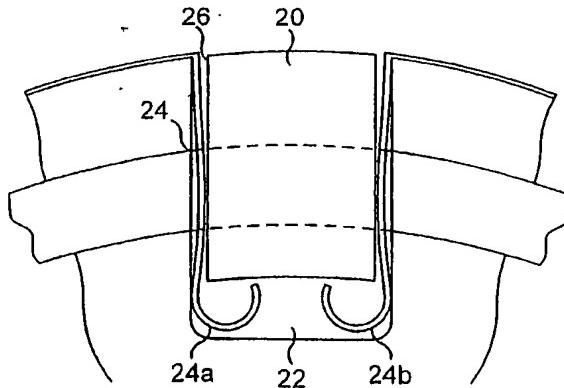
- (51) International Patent Classification⁷: F16H 55/14, (74) Agent: BOOTH, Andrew, Steven; The Boc Group Plc, 57/00, F16D 3/52, F04C 29/00 Chertsey Road, Windlesham, Surrey GU20 6HJ (GB).
- (21) International Application Number: PCT/GB2005/001087 (81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.
- (22) International Filing Date: 22 March 2005 (22.03.2005) (84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).
- (25) Filing Language: English (84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).
- (26) Publication Language: English
- (30) Priority Data:
0406887.0 26 March 2004 (26.03.2004) GB
- (71) Applicant (*for all designated States except US*): THE BOC GROUP PLC [GB/GB]; Chertsey Road, Windlesham, Surrey GU20 6HJ (GB).
- (72) Inventors; and
- (75) Inventors/Applicants (*for US only*): DAVENNE, Tristan, Richard, Ghislain [GB/GB]; Boc Edwards, Unit 2, 23 Dolphin Road, Shoreham By Sea, West Sussex, BN43 6PB (GB). SMITH, John, Cambridge [GB/GB]; Northpoint, The Driftway, Upper Beeding, Steyning, West Sussex, BN44 3JX (GB).

Published:

— with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: GEAR ASSEMBLY



WO 2005/093293 A1

(57) Abstract: A gear assembly for transmitting torque from one shaft to another comprises two intermeshing gears mounted on respective shafts. One of the gears comprises a hub member for receiving one of the shafts, a toothed annular member mounted for rotation with the hub member. At least one spring provided between the hub member and the annular member has stiffness capable of reducing torsional vibrations and noise induced during rotation of the gears by the eccentricity of at least one of the gears.

- 1 -

GEAR ASSEMBLY

The present invention relates to a gear assembly for transmitting torque from one shaft to another, and to a gear suitable for use in such an assembly. The gear
5 assembly is particularly useful for transmitting torque between shafts of a vacuum pump.

With reference to Figure 1, a known vacuum pump includes a pumping chamber through which pass a pair of parallel shafts 1 supported by bearings 2. A rotor 3
10 is mounted on each shaft 1 for rotation within the pumping chamber. The rotors 3 have complementary pumping profiles, which may be Roots, Northey (or "claw") or screw. In use, when a motor 4 is driving one of the shafts 1, the other shaft is rotated synchronously with that shaft by means of the meshed timing gears 5. The rotors 3 are so profiled that fluid to be pumped is drawn into an inlet of the
15 pumping chamber and exits from the pumping chamber via an outlet.

Figure 1 illustrates three different pumping configurations. In Figure 1(a), the rotors 3 are mounted between the bearings 2 and the timing gears 5 are provided at the motor-driven end of the pump. In Figure 1(b), the timing gears 5 are
20 provided at the other end of the pump, and Figure 1(c) illustrates a configuration using cantilevered rotors.

Transmission of torque through the meshed gears 5 is affected by gear eccentricity. Gear eccentricity results in an oscillating drive torque, which would
25 normally be constant with concentric gears. In the case of high inertia, lightly loaded, rotating machinery driven by gears with typical manufacturing eccentricity tolerances, the magnitude of the oscillating drive torque can exceed the steady state drive torque. As a result, the gears leave mesh, which can provoke high frequency tooth-to-tooth slapping, a characteristic noise frequently encountered in
30 lightly loaded rotating machinery.

- 2 -

Pump design has been improved to reduce friction and power consumption. Consequently the required steady state drive torque has reduced and thus rotating machinery has become increasingly prone to eccentricity induced torsional vibrations and related noise problems.

5

It is an aim of at least the preferred embodiment of the present invention to reduce such torsional vibrations and noise by accommodating typical gear eccentricities.

In one aspect, the present invention provides a gear assembly for transmitting
10 torque from one shaft to another, the gear assembly comprising two intermeshing gears mounted on respective shafts, one of the gears comprising a hub member for receiving one of the shafts, a toothed annular member mounted for rotation with the hub member, and means provided between the hub member and the annular member having a stiffness capable of reducing torsional vibrations and
15 noise induced during rotation of the gears by eccentricity of at least one of the gears.

The means for inhibiting torsional vibrations and noise preferably comprises a resilient coupling between the hub member and the annular member. This
20 coupling is preferably located between opposing surfaces of the members. In the preferred embodiment, the resilient coupling is located within a drive mechanism for transferring torque between the members. For example, one member may comprise one or more recesses each for receiving a detent of the other member for transferring torque between the members, the resilient coupling being located
25 between opposing surfaces of the or each recess and detent.

The means for inhibiting torsional vibrations and noise thus preferably comprises at least one resilient member located between opposing surfaces of the members. In the preferred embodiment, a plurality of resilient members are each located
30 between respective opposing surfaces of the members.

The resilient members may be conveniently provided by a number of springs, for example, metal torsional springs or translational springs including flat, disc and coil springs acting along a tangential line within the radius of the member.

- Alternatively, repelling magnets could be used with the resulting stiffness being
5 proportional to the magnetic flux. Finally in some applications use of viscoelastic materials may be appropriate.

Providing means such as a spring between the hub member and the annular member can allow the torsional stiffness of the gear to be controlled.

- 10 By providing a spring between the members the inertia that is accelerated and decelerated due to eccentricity is reduced. As the gear is accelerated, the spring is designed to compress so that the shaft can remain at a constant speed. This isolation of the shaft from eccentricity-induced gear acceleration reduces the oscillations in drive torque and will increase the eccentricity at which the gears will
15 leave mesh.

In the event of an external torque other than that resulting from gear eccentricity causes the gears to leave mesh, the spring will act to absorb the impact that occurs as the gears come back into mesh and thus act to bring the assembly back
20 to the linear, in-mesh, operating region. In support of this argument, non-linear analysis of tooth-to-tooth slapping has shown that the gears can only leave mesh if the overall torsional stiffness is above a certain level. In other words, low torsional stiffness rotating machinery ('weak shafts') would always remain in mesh.

- 25 This aspect of the invention extends to a vacuum pump comprising at least two shafts connected together by a gear assembly as aforementioned. For example, a high-speed Roots blower vacuum pump includes Roots profile rotors rotating in a pumping chamber with a 1:1 gear ratio. Torsional vibrations between the gears can be a problem when operating at maximum speed and ultimate pressure (the
30 best vacuum achievable by the pump). The noise generated has been shown to depend on gear eccentricity, and is present with the available manufacturing gear wheel tolerances. An experimental prototype gear according to the invention

- 4 -

fitted to the driven shaft has been shown to eliminate gear tooth-to-tooth slapping with gear eccentricities that normally result in a pump prone to this noise problem.

In another aspect the present invention provides a gear for transmitting torque
5 from one shaft to another, the gear comprising a hub member for receiving one of the shafts, a toothed annular member mounted for rotation with the hub member, and means provided between the hub member and the annular member having a stiffness capable of reducing torsional vibrations and noise induced during use by the eccentricity of the annular member.

10

A further aspect of the invention provides use of at least one spring in a gear of a gear assembly to reduce torsional vibrations and noise induced during rotation of the gears by the eccentricity of at least one of the gears.

15 Preferred features of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 illustrates schematically three known pump configurations;

20 Figure 2 is a cross-section of a gear suitable for use in any of the pumps of Figure 1; and

Figure 3 is a cross-section illustrating the mechanism for transmitting torque between the hub member and annular member of the gear of Figure 2.

25

With reference to Figure 2, a gear 10 suitable for use in any of the vacuum pumps shown in Figure 1 or in any other lightly loaded, high inertia rotating machine comprises a hub member 12 for receiving a shaft of the pump and an annular member 14 mounted for rotation with the hub member 12 and having peripheral teeth 16. The shaft received by the hub member 12 may be either a drive shaft or a driven shaft of the pump. A bearing assembly 18 is carried by the bore of the annular member 14 and the shaft.

In use, the peripheral teeth 16 of the annular member 14 are in meshing engagement with the corresponding teeth of another gear having a 1:1 gear ratio with the gear 10, similar to the timing gears 5 shown in Figure 1.

5

A drive mechanism for transmitting torque between the members 12, 14 is provided by a plurality of detents provided around a surface perpendicular to the rotational axis of one of the members which enter respective recesses provided around the facing axial surface of the other member. In the embodiment shown in 10 Figure 2, detents 20 are provided on the annular member 14 and recesses 22 are provided on the hub member 12, although this could be the other way around, with the detents being provided on the hub member and the recesses provided on the annular member.

15 As shown in Figure 3, flat springs 24a, 24b are located within each recess 22 between the facing radial surfaces 26, 28 of the detent 20 and recess 22. The springs 24a, 24b have a stiffness chosen to substantially inhibit torsional vibrations and noise induced under lightly loaded conditions by eccentricity of either the annular member 14 or of the gear meshing with the teeth 16 of the annular 20 member 14. The springs 24a, 24b also provide absorption of any tooth-to-tooth impact resulting from external disturbances.

Under lightly loaded conditions, as experienced by a pump operating at ultimate pressure, the transmission of torque between the members 12, 14 is through one 25 of the springs 24a, 24b provided within each recess 22. This provides a degree of resilience necessary to accommodate any gear eccentricity.

In the event of the pump being subject to higher loads where a solid drive is needed to avoid compromising the phase relationship between the driving and 30 driven shafts, the spring flattens between the facing radial surfaces 26, 28 once the angular deflection of the spring has reached a specified value above a

- 6 -

predetermined drive torque. This provides the necessary solid drive between the radial faces 26, 28.

Whilst in this embodiment flat springs have been used to control torsional stiffness,

5 tangentially mounted disc springs or coil springs could be used instead.

Alternatively, repelling magnets could be used, with the resulting torsional stiffness being proportional to the magnetic flux. In some applications, use of viscoelastic materials may be appropriate.

CLAIMS

1. A gear assembly for transmitting torque from one shaft to another,
5 the gear assembly comprising two intermeshing gears mounted on
respective shafts, one of the gears comprising a hub member for
receiving one of the shafts, a toothed annular member mounted for
rotation with the hub member, and means provided between the hub
member and the annular member having a stiffness capable of
10 reducing torsional vibrations and noise induced during rotation of the
gears by the eccentricity of at least one of the gears.
2. A gear assembly according to Claim 1, wherein the means for
reducing torsional vibrations and noise comprises means for
15 increasing the critical eccentricity of the gear.
3. A gear assembly according to any preceding claim, wherein the
means for reducing torsional vibrations and noise comprises a
resilient coupling between the hub member and the annular member.
20
4. A gear assembly according to any preceding claim, wherein the
means for reducing torsional vibrations and noise is located between
a radial surface of the hub member and an opposing radial surface of
the annular member.
25
5. A gear assembly according to any preceding claim, wherein the
means for reducing torsional vibrations and noise is located within a
drive mechanism for transferring torque between the hub member
and the annular member.
30
6. A gear assembly according to Claim 5, wherein one of the hub
member and the annular member comprises a recess for receiving a

detent of the other of the hub member and the annular member for transferring torque between the hub member and the annular member, the means for reducing torsional vibrations and noise being located between opposing surfaces of the recess and the detent.

5

7. A gear assembly according to Claim 6, wherein said one of the hub member and the annular member comprises a plurality of said recesses each for receiving a respective detent of the other of the hub member and the annular member, the means for reducing torsional vibrations and noise being located between opposing surfaces of each recess and detent.
10. A gear assembly according to any preceding claim, wherein the means for inhibiting torsional vibrations and noise comprises at least one resilient member located between opposing surfaces of the hub member and the annular member.
15. A gear assembly according to Claim 8, wherein the means for inhibiting torsional vibrations and noise comprises a plurality of resilient members each located between respective opposing surfaces of the hub member and the annular member.
20. A gear assembly according to Claim 9, wherein each resilient member comprises a spring for providing torsional resistance.
25. A gear assembly according to Claim 9, wherein each resilient member comprises a plurality of springs for providing torsional resistance.
30. 12. A gear assembly according to Claim 9, wherein each resilient member comprises a viscoelastic member.

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13. A gear assembly according to any of Claims 1 to 7, wherein the means for reducing torsional vibrations and noise comprises mutually repelling magnets provided on opposing surfaces of the hub member and the annular member.

5

14. A gear assembly according to any preceding claim, wherein the means for reducing torsional vibrations and noise is arranged to maintain the phase relationship between the shafts.

10 15. A gear assembly according to Claim 14, wherein the means for reducing torsional vibrations and noise is arranged to permit a solid drive to be established between the hub member and the annular member above a predetermined drive torque.

15 16. A vacuum pump comprising at least two shafts connected together by a gear assembly according to any preceding claim.

17. A gear for transmitting torque from one shaft to another, the gear comprising a hub member for receiving one of the shafts, a toothed annular member mounted for rotation with the hub member, and means provided between the hub member and the annular member having a stiffness capable of reducing torsional vibrations and noise induced during use by eccentricity of the annular member.

20 25 18. Use of at least one spring in a gear of a gear assembly to reduce torsional vibrations and noise induced during rotation of the gears by eccentricity of at least one of the gears.

1 / 2

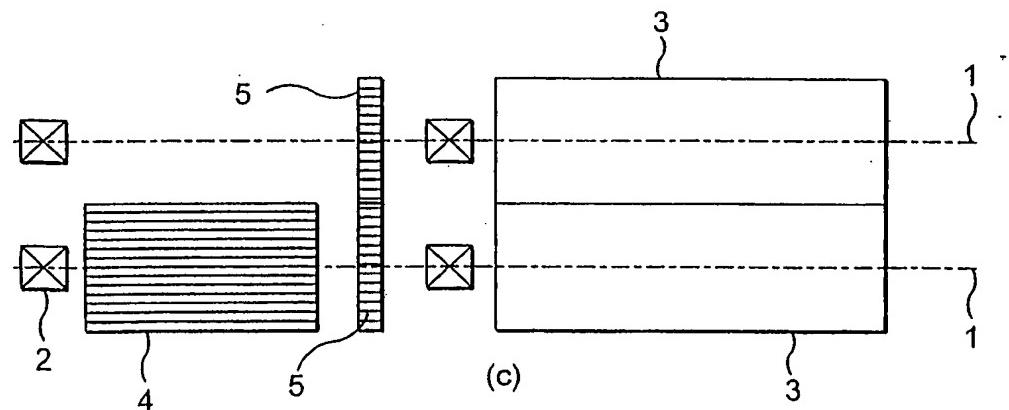
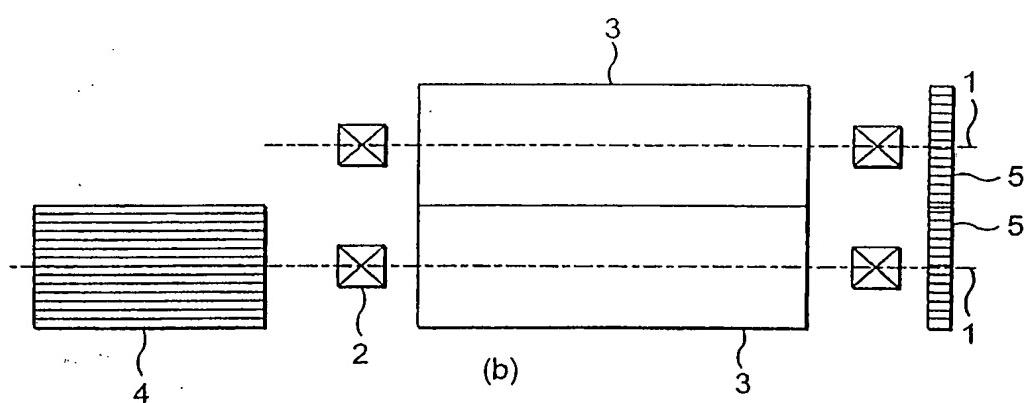
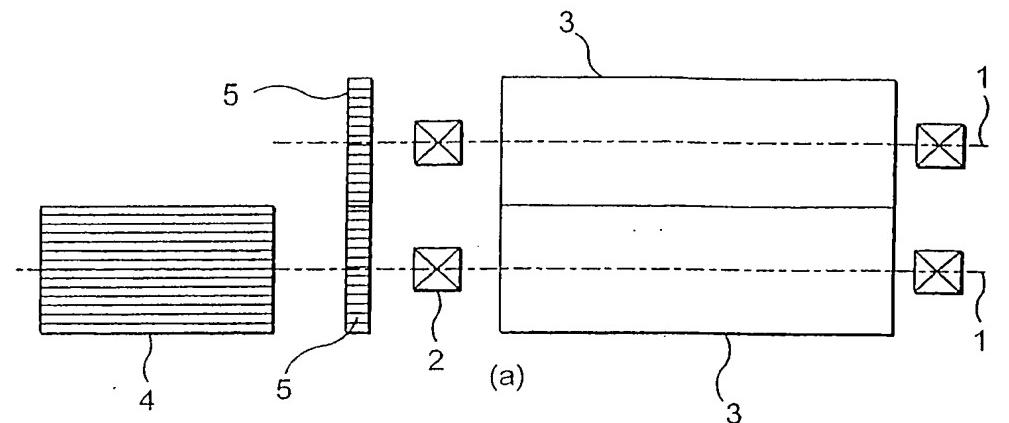


FIG. 1

2 / 2

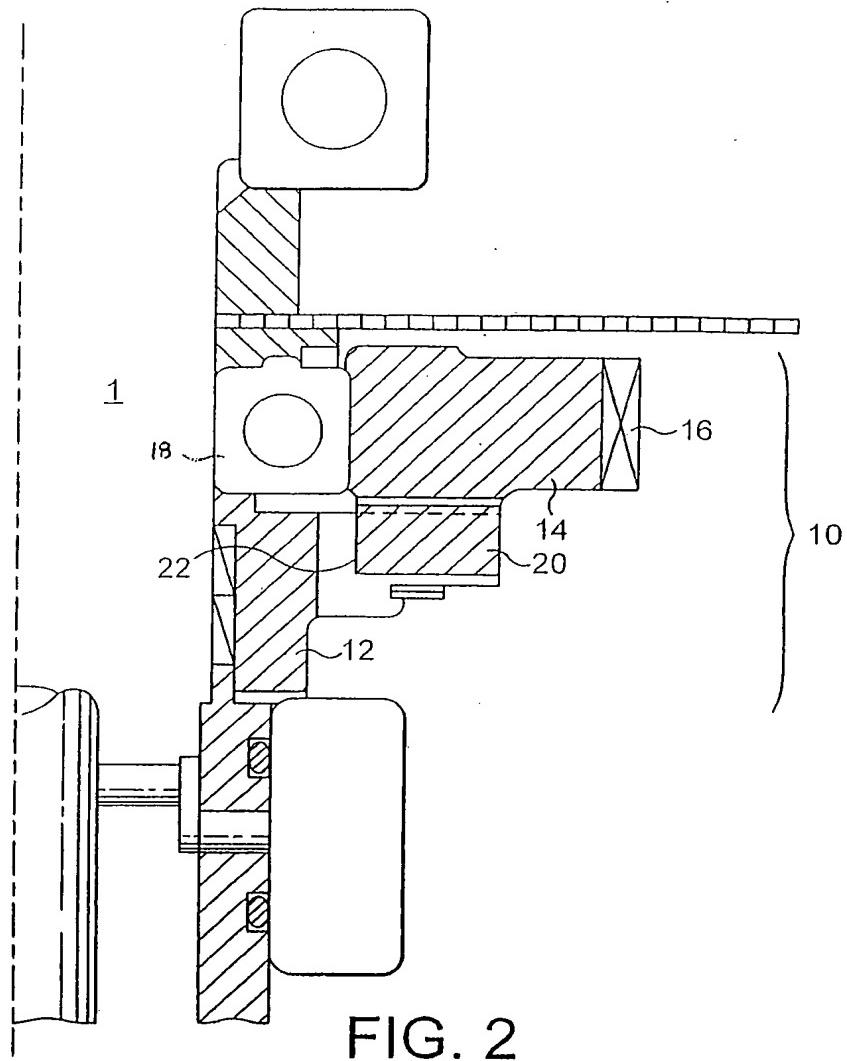


FIG. 2

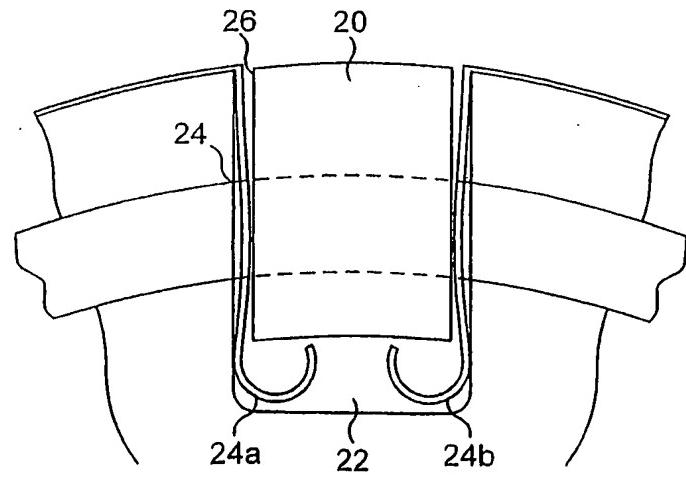


FIG. 3

INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB2005/001087

A. CLASSIFICATION OF SUBJECT MATTER
 IPC 7 F16H55/14 F16H57/00 F16D3/52 F04C29/00

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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	PATENT ABSTRACTS OF JAPAN vol. 2003, no. 04, 2 April 2003 (2003-04-02) & JP 2002 349672 A (MITSUBISHI MOTORS CORP), 4 December 2002 (2002-12-04) abstract; figures 1,3	1-9, 12, 14-17
X	US 86 533 A (JOHN HAFFNER) 2 February 1869 (1869-02-02) figure 5	1-5, 8, 14, 17, 18
X	US 5 692 410 A (FENELON ET AL) 2 December 1997 (1997-12-02) the whole document	1-11, 14, 17, 18
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Date of the actual completion of the international search

10 June 2005

Date of mailing of the international search report

22/06/2005

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB2005/001087

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	BE 488 019 A (STAATSMIJNEN NEDERLAND) 15 April 1949 (1949-04-15) page 4, line 2 - line 29; figures 1-3 -----	1-8, 14, 17, 18
X	US 5 259 261 A (MICHEL ET AL) 9 November 1993 (1993-11-09) column 2, line 46 - line 62 -----	1-5, 8, 14, 17, 18
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X	US 3 991 818 A (WAGNER ET AL) 16 November 1976 (1976-11-16) the whole document -----	1-5, 8-12, 14, 17, 18
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A	DE 101 14 079 A1 (CARL FREUDENBERG KG) 2 October 2002 (2002-10-02) column 4, line 2 - line 8; figure 1 -----	13
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INTERNATIONAL SEARCH REPORT

Information on patent family members

Int'l. Application No PCT/GB2005/001087
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Patent document cited in search report		Publication date		Patent family member(s)		Publication date
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US 5893355	A	13-04-1999		NONE		

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Application Number	10/594,260
Filing Date	September 25, 2006
First Named Inventor	DAVENNE et al.
Title	GEAR ASSEMBLY
Art Unit	
Examiner Name	
Attorney Docket Number	M04B101

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ASSIGNMENT

WHEREAS, I/We, Tristan Richard Ghislain Davenne and John Cambridge Smith, a citizen of/ citizens of the United Kingdom, residing at 15 Chapel Road, Epping, Essex, CM16 5DS, United Kingdom; and Northpoint, The Driftway, Upper Beeding, Steyning, West Sussex, BN44 3JX, United Kingdom, have invented certain new and useful improvements in GEAR ASSEMBLY for which I/We have made application for Letters Patent of the United States, which application may be identified in the United States Patent and Trademark Office as Serial No. 10/594,260, filed September 25, 2006; which application claims priority from International Application No. PCT/GB2005/001087, filed March 22, 2005; and,

WHEREAS, Edwards Limited, an English Company of Manor Royal, Crawley, West Sussex, RH10 9LW, United Kingdom, is desirous of obtaining the entire right, title and interest in, to and under the said improvements and the said application:

NOW, THEREFORE, in consideration of the sum of One Dollar (\$1.00) to me/us in hand paid, and other good and valuable consideration, the receipt of which is hereby acknowledged, I/WE, the said Tristan Richard Ghislain Davenne and John Cambridge Smith have sold, assigned, transferred and set over, and by these presents do hereby sell, assign, transfer and set over, unto the said **Edwards Limited**, its successors, legal representatives and assigns, the entire right, title and interest in, to and under the invention, the said improvements, and the said application, all applications derived therefrom and all continuing prosecution applications, conversions, divisions, renewals and continuations thereof, and all Letters Patent of the United States which may be granted thereon and all reissues and extensions thereof, and all applications for Letters Patent or Inventor's Certificates which may hereafter be filed for said improvements in any country or countries foreign to the United States, and all Letters Patent or Inventor's Certificates which may be granted for said improvements in any country or countries foreign to the United States and all extensions, renewals and reissues thereof; and I/We hereby authorize and request the Commissioner of Patents of the United States, and any Official of any country or countries foreign to the United States, whose duty it is to issue patents on applications as aforesaid, to issue all Letters Patent for said improvements to the said **Edwards Limited**, its successors, legal representatives and assigns, in accordance with the terms of this instrument.

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AND I/WE HEREBY further covenant and agree that I/We will communicate to the said **Edwards Limited**, its successors, legal representatives and assigns, any facts known to me/us respecting said invention and said improvements, and testify in any legal proceeding, sign all lawful papers, execute all continuing prosecution, divisional, continuing, reexamination and reissue applications, make all rightful oaths, and generally do everything possible to aid the said **Edwards Limited**, its successors, legal representatives and assigns, to obtain and enforce proper patent protection for said inventions and improvements in all countries.

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October 22, 2007

Mr. Tristan Richard Ghislain Davenne
15 Chapel Road
Epping
Essex CM16 5DS
United Kingdom

RE: U.S. Patent Application No. 10/594,260
Filing Date: September 25, 2006
Title: GEAR ASSEMBLY
Dkt. No. M04B101

Dear Mr. Davenne:

Pursuant to my October 9, 2007 letter, please be reminded that we have not yet received back from you the declaration, assignment, and power of attorney documents relating to the subject patent application. Please execute the forms as soon as possible and return them to me by no later than October 24, 2007.

Please contact me as soon as possible.

Thank you again for your immediate attention to this matter.

Best Regards,

Kristi Nicholes | Patent Agent | Edwards
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2:19 am	In transit.	Wilmington - Clinton Field, OH
10/22/2007 8:58 pm	Departing origin.	Parsippany, NJ
7:38 pm	Shipment picked up	Parsippany, NJ
Ship From:	Ship To:	Shipment Information:
BOC EDWARDS INC Morristown, NJ 07960 United States	Epping Essex, United Kingdom	Ship date: 10/22/2007 Pieces: 1 Total weight: 1 lb *
Attention: BOC EDWARDS INC	Attention:	Ship Type: Shipment Reference: M04B101 Service: Express Special Service: Description: DOCS

Tracking detail provided by DHL: 10/24/2007, 5:59:12 am pt.

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*** Note on weight:**

The weights displayed on this website are the weights provided when the shipment was created. Actual chargeable weights may be different and will be provided on invoice.



RECEIVED

OCT 22 2007

By: B. Lee
EDWARDS VACUUM, INC.
Intellectual Property

Tristan Davenne
c/o BOC Edwards
Unit 2
Dolphin Road
Shoreham By Sea
West Sussex
BN43 6RH

Our Ref. Phone Fax E-mail Date
M04B101US/AS8 +44.1276.807537 +44.1276.807785 Cathy.Kelly@boe.com 8 November 2006

**US PATENT APPLICATION NO. 10/594,260
ENTITLED GEAR ASSEMBLY
THE BOC GROUP plc**

Dear Tristan,

The above mentioned patent application for which you are a named Inventor has been filed in the United States of America. Ira Zebrak who is a US Patent Attorney at our site in Murray Hill has asked me to obtain your signature for assignment and declaration documents so this application can proceed in the United States.

Please sign the documents and return to me at the below address in the envelope provided and I will forward them back to Ira Zebrak after I have obtained the other inventors signatures.

Please do not hesitate to contact me should you have any queries.

Yours sincerely

Cathy Kelly
Intellectual Property Formalities Administrator
Legal Services

Linde and The BOC Group have merged to become The Linde Group. For further information please visit www.linde.com

The BOC Group plc. Registered Office: Chertsey Road, Windlesham, Surrey GU20 6HJ. England. Number 22096 English Register
For postal deliveries please use the following details:
The BOC Group plc., Chertsey Road, Windlesham, Surrey GU20 6HJ
Phone: +44.1276.477222, Fax: +44.1276.471333



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OCT 22 2007

By: B. Lee
EDWARDS VACUUM, INC.
Intellectual Property

Tristan Davenne
5 Adelaide Square
Shoreham-by-Sea
West Sussex
BN43 6LN

Our Ref. M04B101US/ASB Phone +44.1276.807612 Fax +44.1276.807785 E-mail Cathy.Kelly@boe.com

Date 22 November 2006

US PATENT APPLICATION ENTITLED GEAR ASSEMBLY - SERIAL NO. 10/594,260
THE BOC GROUP, plc

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Yours sincerely

Cathy Kelly
Intellectual Property Formalities Administrator
Legal Services

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Phone: +44.1276.477222, Fax: +44.1276.471933



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By: B. Lee
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Intellectual Property

Tristan Davenne
5 Adelaide Square
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West Sussex
BN43 6LN

Our Ref. M04B101US/ASB Phone +44.1276.807537 Fax +44.1276.807785 E-mail Cathy.Kelly@boe.com

Date 20 December 2006

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THE BOC GROUP plc**

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Please sign the documents and return to me at the below address in the envelope provided and I will forward them back to Ira Zebrak after I have obtained the other inventors signatures.

This matter is now urgent, if there is a problem with signing these documents please could you contact me ASAP. If you have already signed and returned the documents to me please could you contact me and let me know when they were sent.

Please do not hesitate to contact me should you have any queries.

Kind regards

Cathy Kelly
Intellectual Property Formalities Administrator
Legal Services

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Phone: +44.1276.477222, Fax: +44.1276.471333

Nicholes,Kristi

From: Tribe,Julia
Sent: Friday, May 11, 2007 10:06 AM
To: Lee,Betty
Cc: Booth,Andy-WIN
Subject: RE: M04B101

Dear Betty

I have made some enquiries into this matter and have found the documents as signed by John Smith on file. These documents were given to Tristan Davenne for completion prior to his departure from BOC, but he refused to sign them and left them on his desk upon departure. We have no forwarding address for him and have been unable to trace his whereabouts. We therefore believe we have made every reasonable endeavour to contact him.

In light of this, could you please prepare the necessary documents for dealing with such occurrences. In the meantime, please confirm whether or not you would like me to return the documents that have been signed by John Smith.

Many thanks - have a good weekend.

Regards

Julia

Legal Services
The Linde Group

phone: +44.1276.807692
fax: +44.1276.807785

Visit us at - <http://bocweb13.group.boc.com/legal_global/intellectual_property/index.asp>
or - <http://145.225.250.14/legal_global/>

-----Original Message-----

From: Lee,Betty
Sent: 10 May 2007 20:17
To: Booth,Andy-WIN
Cc: Tribe,Julia
Subject: M04B101
Importance: High

Dear Andy:

Pursuant to Ira's **November 7, 2006**, memo, we have not yet received back from you the signed declaration, assignment, and power of attorney forms for the subject case.

If you did not receive the documents, we will re-send.

Thank you.

Regards,
Betty

Betty Lee
Legal Services
The Linde Group
phone: +1.908.771.6481

Visit us at - <[>>](http://bocweb13.group.boc.com/legal_global/intellectual_property/index.asp)